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TESIS DOCTORAL

Essays on Economic Development: Pre-Independent Algeria at the Beginning of the 1900s

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ESSAYS ON ECONOMIC DEVELOPMENT: PRE-INDEPENDENT ALGERIA AT THE BEGINNING OF THE 1900s

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List of Abbreviations

ANOM	*Archives Nationales d'Outre-Mer*
ANOM-iREL	*Archives Nationales d'Outre-Mer-Instruments de Recherche en Ligne*
ASF	*Annuaire Statistique de la France*
CBG	*Compagnie de Bône-Guelma*
CCFA	*Compagnie des Chemins de Fer Algériens*
CCO	*Carte de la Colonisation Officielle*
CEA	*Compagnie de l'Est Algérien*
CEPC	*Carte des Étapes de la Province de Constantine*
CI	*Commune Indigènes*
CM	*Commune Mixte*
CPE	*Commune de Plein Exercice*
CVC	*Carte des Voies de Communication*
DdC	*Dictionnaire des Communes, Villes et Villages de l'Algérie*
GGA	*Gouvernement Général de l'Algérie*
INE	*Instituto Nacional de Estadística*
SA	*Statistique Agricole*
SGA	*Statistique Général de l'Algérie*
TdCF	*Tableau du Commerce de la France*
TGdC	*Tableau Général ... des Communes*

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Chapter 1

Introduction

Economic theory argues that factor endowments – i.e., the relative intensities of land, labor, and capital – together with institutional factors – such as the enforcement of property rights and technological innovation – explain the causes and constraints of economic growth and development. However, the underlying mechanisms are still unclear, and the numerous models built to account for economic development provide results that are frequently far from reality. In economic history the understanding as to how all these factors, namely factor endowments (such as the land-to-labor ratio) and institutions of different kinds, forged prosperity (or poverty) across countries is often traced back to colonialism and agriculture. Thus, the analysis of historic cases during the colonial years, illustrating the way crops, agricultural techniques, and farm sizes adapted to the new environments generated by rural settlement, can contribute to the understanding of economic growth and development.

This thesis examines rural settlement in the department of Constantine in French Algeria at the turn of the twentieth century, shedding light onto the mechanisms through which its agrarian structure was altered. Historians argue that the Algerian economy was transformed during French colonization. With the arrival of the French in the 1830s, the colonial administration aimed to establish a settler rural society based on smallholdings and family farms. Instead, it resulted in a speculative cash crop production colony based on relatively large estates devoted mainly to the cultivation of wheat and wine. It is frequently argued that colonialism forged a dual economy between an Algerian or indigenous "traditional" subsistence rural sector and a settler "modern" export-led one. Additionally, the progressive tendency towards large cash crop estates led to the "crowding out" or decline of smallholding settlers. Thus, on the eve of Independence in 1962, the country was not only endowed with high levels of land inequality and a dual economy and society, but it became clear that the colonial administration had failed to achieve what it had initially hoped for: a smallholding family farm type of settler economy.

Examining rural settlement in Constantine helps identify the variables that are commonly regarded in economic history as the main forces explaining regional differences in long-term economic growth and development (Acemoglu et al., 2001; Dell, 2010; Diamond, 1999; Enger-

man and Sokoloff, 2002; Frankema, 2010). There is no clear-cut answer as to which are the most significant determinants, and the interdependency between them further complicates the analysis. Some argue that the predictive power of the regional differences resides in the direct effect that geographic factors have on production functions (Diamond, 1999), while others rely on pre-colonial determinants, such as agricultural transitions and ethnic institutions (Galor and Moav, 2007; Michalopoulos and Papaioannou, 2013). However, there is a growing amount of literature providing overwhelming evidence on the impact of colonial settlement on long-term inequality and growth (Acemoglu et al., 2001, 2002; Easterly, 2007; Easterly and Levine, 2016; Putterman and Weil, 2010).

Nevertheless, the channels through which settlement affects long-term economic development are also unclear. Some find that the interaction between geographic variables and settlement changed the economy by altering the modes of production (Austin, 2008; Fenske, 2014; Mosley, 1983). Others argue that it was more based on institutions through colonial taxes and land policies (Frankema, 2011; Huillery, 2014). Alternative hypotheses claim that the major colonial institutional forces were channeled via the transfer of human capital (Cogneau and Moradi, 2014; Glaeser et al., 2004), the infrastructure density (Donaldson, 2010; Jedwab and Moradi, 2016), or the legal origin (La Porta et al., 2008).[1] It has also been argued that colonial institutions were not exogenous and were ultimately shaped by the local factor endowments – such as the geographic conditions or the quantities of productions factors – encountered in the colonized regions (Acemoglu et al., 2001, 2002; Acemoglu and Robinson, 2012; Easterly, 2007; Engerman and Sokoloff, 2002). Controlling for all these mechanisms and isolating a specific one can be confusing, particularly when aggregating many countries together in the empirical framework.

In addition, many of these studies tend to explain long-term differences using an explanatory variable at a fixed point in time (e.g., population density or degree of urbanization in the year 1500) as a proxy to "settlement." As Frankema et al. (2014, p. 4) explain, this approach neglects changes within the process itself, and colonial settlement must not be regarded as an "event [. . .] at a given point in time," rather it must be studied as a process that experienced significant changes throughout the colonial years. Indeed, extensive research on economic development builds on Acemoglu, Johnson, and Robinson's (2001, p. 1369) argument that "Europeans adopted very different colonization policies in different colonies, with very different associated institutions" to explain long-term economic growth and income distribution.[2] However, only a few scholars have taken into account that Europeans adopted different colonial land appropriation and redistribution policies within a colony itself, depending on the region being occupied and the timing of settlement. The data available for Constantine provides an opportunity to study

[1] Legal origin refers to the legal systems such as the British common law, French civil law, and German and Scandinavian civil law.

[2] For instance, "settler economies" (e.g., Kenya, South Africa, and Zimbabwe), which were characterized by intensive European settlement and major land transfers from indigenous populations to settlers, are related to higher land inequality and lower potential for growth, as opposed to "peasant export" economies (i.e., Ghana and Uganda), where local populations were less affected by land policies and smallholders were able to participate in exports (Bowden et al., 2008; Haas, 2017).

how settlers responded, according to their timing of settlement, to differences in land-market institutions, relative factors of production, and infrastructures, thus contributing to the debates regarding the colonial effects on long-term development.

Furthermore, much of the literature tends to consider Africa as a whole, excluding relevant inter-country heterogeneities that should be included in the assessment of the impact of colonization on growth (Bertocchi and Canova, 2002). Indeed, Algeria has been situated inaccurately in comparative studies, leading to what Austin (2008, p. 998) defines as "compression of history." For instance, the author points out this weakness in Acemoglu et al. (2001), whose research design categorizes all African countries as "non-settler colonies," without taking into consideration that:

> [...] the division between colonies with and without European settlement operated within Africa itself, creating – or perhaps being part of – a different kind of historical path than that taken by the non-settler economies of the continent.

Others have improved accuracy by limiting comparison to the North African region or to similar settler colonies (Elkins and Pedersen, 2005; Huillery, 2014; Lützelschwab, 2013; Mosley, 1983). In general, French Algeria is regarded as a settler economy that, particularly in relation to its long-run economic performance, should be included into a "somewhat different type of settler colonialism that emerged in Africa over the 19th Century and early 20th Centuries" (Lloyd and Metzer, 2013, p. 2).[3] It was characterized by having a settler population smaller in size to the indigenous one, and a *mètropole* endowed with a significant economic, political, and often military power, that maintained the colony's dependence on it.[4] In comparative studies, Algeria is usually positioned together with Southern Rhodesia, Kenya, and South Africa (Lloyd and Metzer, 2013; Lützelschwab, 2013; Osterhammel and Frisch, 1997). Scholars find that these countries share three characteristics that allow for comparison: the relative share of land owned by settlers, the dependence of settlers on the availability of indigenous labor, and the role of the state representing settlers and determining access to land and labor (Lützelschwab, 2013).

However, Algeria stands out from the rest because it was "geographically, politically and economically" nearest to the "mother country" (Good, 1976, p. 598), and it experienced, together with South Africa, the highest growth and share of settler population relative to the total population (Lützelschwab, 2000). In addition, the land appropriation process was mostly undertaken after conquest, entailing a complex procedure where native traditional land norms and titles were intertwined with innovative French administrative measures (Lützelschwab, 2000). Finally, in contrast to the other settler economies, it was considered as an integral part

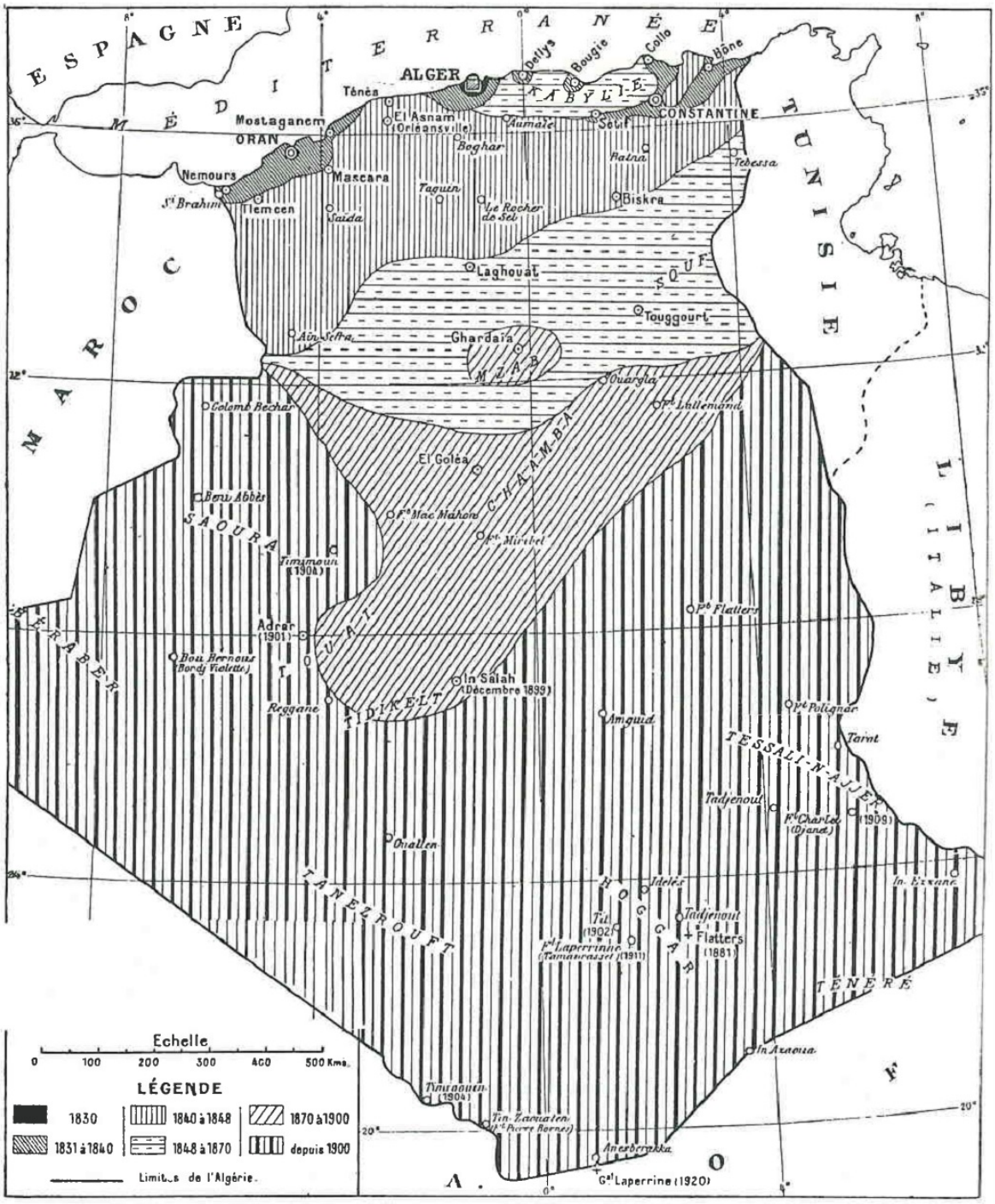
[3] As explained by Lloyd and Metzer (2013, p. 2) there are also the "Neo-Europe" or "modern" type of settler economies of the late 18th and 19th centuries such as the New World colonies (e.g. the United States, Canada or Australia), and the "older" type more prevalent in the 18th century.

[4] This type of settler economy is explained by the existence of four important agents: "an imperial *métropole* where sovereignty formally resides, a local administration charged with maintaining order and authority, an indigenous population significant enough in size and tenacity to make its presence felt, and an often demanding and well-connected settler community" (Elkins and Pedersen, 2005, p. 4).

of France, and thus enjoyed a preferential trade policy that guaranteed a market demand that fully absorbed its agricultural exports, at a particular moment in history when many countries returned to protectionist policies as a response to New World grain competition after the 1870s. Hence, analyzing a different case of a settler economy can provide new insights into the effects of colonialism on agrarian structures.

With historic data, primary and secondary literature, and quantitative empirical methods, this study identifies the colonial forces explaining regional differences in population densities and rural land concentration (i.e., more land in fewer hands). The structure is as follows. The next sections describe the international framework, discussing the factors that pushed Algeria to specialize in cereal and wine production, and provide an overview of Constantine's regional characteristics and settlement process. Chapter 2 examines how land-market institutions affected land concentration, ultimately explaining the lower density levels of family farm settlers. Chapter 3 analyzes how "first nature" geographic variables – such as land aridity – and the relative factor endowments – specifically the arable land-to-labor ratio – influence economic activity by shaping agricultural innovation and land concentration. Finally, Chapter 4 examines whether the railway infrastructure built without thorough planning in remote regions affected the settler and indigenous Algerian population density levels.

Figure 1.1: Map of French occupation in Algeria after 1830



Source: Yacono (1993, p. 262). Original source: Guernier, E. (1946) *Algérie et Sahara*, *Encyclopédie coloniale et maritime, tome 1*, Paris.

Outline of the Current Situation and Importance of Research

In this context, it is necessary to explain why I focus on agriculture. The study of Algeria's colonization could easily be included in numerous growth and development policy debates in economic history. For instance, I could have examined the effects of trade integration as French policy facilitated exports and accelerated growth by implementing a "tariff assimilation" policy (Ageron, 1991; Girault, 1916), or, alternatively, I could have focused on the legacy and effects of the transfer of French institutions as these were adapted to Algeria.[5] Thus, why agriculture?

Agriculture represents a significant share of the Algerian economy: its contribution to GDP in 2014 was estimated to be over 10 percent, in contrast to an average of 6 percent for the Middle East and North Africa, and a 3.9 percent world average.[6] However, as Daoudi and Colin (2016) explain, since the 1970s, agricultural production has struggled to meet a growing domestic food demand caused by persistent population growth and improved standards of living (brought about by the industrial and service sector). Water resources are negligible and the proportion of arable land reported in 2014 was only 2 percent of the total surface area (2,381,740 square kilometers).[7]

To increase agricultural production and guarantee food security, the Algerian government currently seeks to boost small farming, diversify agricultural production, expand cultivation in arid regions (the steppes and Sahara Desert), and invest in infrastructure (Daoudi and Colin, 2016). Indeed, since Independence in 1962, most governmental plans have aimed at redistributing land, enhancing rural production, and decreasing food insecurity by implementing measures such as modifying land ownership, expanding cultivation, and improving infrastructures (Laoubi and Yamao, 2012).[8] Yet, as Laoubi and Yamao (2012) argue, the majority of governmental plans implemented after independence have actually failed to enhance agricultural production.

Some of the origins of the obstacles encountered by post-colonial Algeria to fulfill these goals can be traced back to the colonial years. For instance, a central issue addressed in this thesis (mainly in Chapters 2 and 3) is the evolution of landownership which, according to Laoubi and Yamao (2012), is at present a major constraint to Algerian agricultural development. After Independence the Algerian government undertook the "most considered and ambitious" land reform among the Maghreb countries (Smith, 1975, p. 260),[9] and, since then, it has engaged in numerous agricultural development plans targeting land redistribution. Thus, and in line with Binswanger et al. (1995), the increasing consensus on the relevance of land redistribution policies

[5] Specifically, colonial representation in French Parliament, centralized direct government, and the idea of applying the same laws to all citizens without considering "differences in size, distance from France, social organization, religious patterns, economic development, etc." (Lewis, 1962, p. 131).

[6] The World Bank, World Development Indicators (2017). Agriculture, value added (% of GDP), retrieved from http://databank.worldbank.org/data/reports.aspx?source=2&country=DZA.

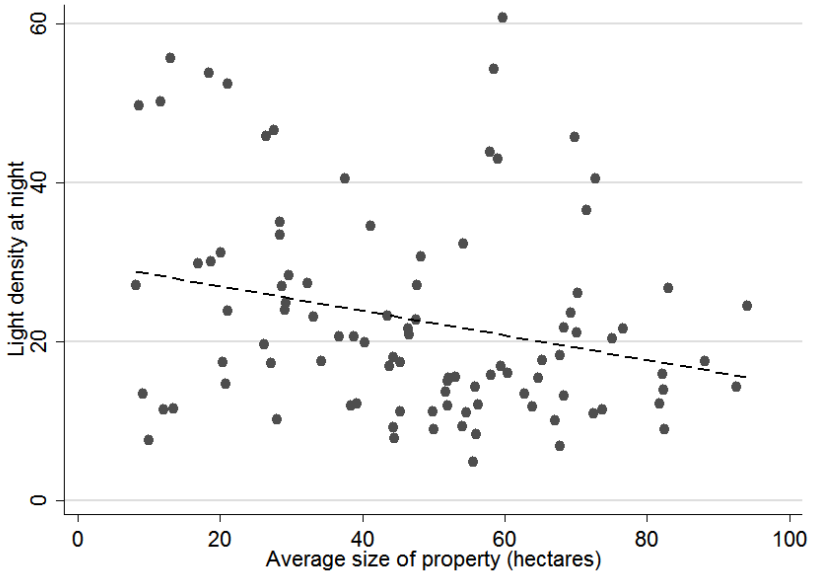
[7] Food and Agriculture Organization of the United Nations (2017). Land use and agricultural area, retrieved from http://www.fao.org.

[8] "Autogestation" policy (1962-1970), "Agrarian Revolution" policy (1971-1979), transition to market economy (1980-1986), new farm restructuring (1987-1999), and the National Agricultural and Rural Development Program (2000...).

[9] Countries such as Egypt, Iraq, Pakistan, Syria, and Tunisia also undertook post-Independence land reforms.

highlights the necessity to examine the origins of land concentration.

Figure 1.2: Light density at night in year 2013 and average property size in 1913/14 in Constantine



The dashed line is the trend line for the year 1913/14. *Average size per property* is the European average property size in hectares per municipality in the year 1913/14. *Light density at night* displays lights from cities, towns, and other sites with persistent lighting, including gas flares in the year 2013. For detail on the construction of variables see Appendix D. *Source*: SA (1913/14) and NOAA's National Geophysical Data Center.

According to Griffin (1976), who participated in Algeria's post-Independence agricultural planning in 1963, rural areas in developing countries are usually endowed with societal structures that impede redistribution of resources and hinder growth. High levels of land concentration – which in the case of Algeria originated during the colonial years – correspond to fragmented rural labor markets. These are characterized by low wages, very small holdings, high land rents, and underutilization of land. Furthermore, the majority of the landless (or quasi-landless) population loses bargaining power, and therefore inequality is consolidated, economic growth decreases, and inefficiency is generated. As an illustration, in line with this argument, Figure 1.2 suggests that the current economic activity (proxied by light density at night) in the regions endowed with larger properties in the past has lagged behind.[10]

Thus, given that family farming (or individually run) is found to boost local economies, contribute to production diversification, and provide sustainable agriculture (Food and Agriculture Organization of the United Nations, 2014), it is comprehensible that, since its arrival to Algeria, the French government prioritized the establishment of a peasant, family farm economy and that, even today, the Algerian government encourages family farming. The government has also undertaken additional measures that link as well to the colonial origins of the current

[10]Using light density at night as a proxy to economic activity is a standard procedure used in research. Given the lack of current economic activity data at a municipal level (corresponding to the 1900s boundaries), and in line with Michalopoulos and Papaioannou (2013), I have used the light density at night in 2013. See Appendix D for further detail on construction. In addition, the pairwise correlation between the night light density and alternative variables accounting for colonialism (for both the years 1904/5 and 1913/14) is significant at a one percent confidence level: i. a -0.31 (N=198) with the average year of creation of a settlement center and, ii. a 0.21 (N=198) with the road network density.

agrarian structure. For instance, it seeks to increase agricultural diversification, which indeed originated during the colonial years. A number of variables, such as the French tariff assimilation policy, international cereal prices, and the *phylloxera* vineyard aphid pushed settlers to specialize solely in cereal and wine production. Furthermore, past and present governmental policies show interesting similarities; for example, at present the government aims at expanding cultivation in arid regions that, during the colonial years, was also a key policy to the development of the cereal export-led sector and large landholdings.[11] This does not imply that colonialism was the sole determinant of agrarian structural problems, but it does highlight the importance of understanding the past in order to provide useful lessons for future policy making.

The International Trade Context

In line with the Old World market, and in contrast to New World settler economies such as the United States, Canada, or Australia, pre-colonial commercial relations were strong in Algeria. The Greeks and Phoenicians had already established trading towns on the North African coast around the seventh century B.C., and the trade between France and Algeria dated back to the Middle Ages (Bennoune, 2002). These commercial links were reinforced by a geographical proximity and a political union that established Algeria as an integral part of France. Thus, the colony took advantage of its trade privileges with France and specialized mainly in cereal and wine production.

Indeed, the colonial years deepened Algeria's pattern of export specialization. After the fall in international grain prices in the 1870s, cereal farmers in the grain exporting countries – in order to be competitive in world markets – could either minimize the costs of production or change to a more attractive crop.[12] In Algeria, a large number of French farmers turned to viticulture. This positioned the country within the New World type of wine producers that, in contrast to the Old World, were characterized by modern wineries that benefited from technological progress and produced economies of scale (Simpson, 2011b). However, many of the Algerian farmers decided to stick to cereal cultivation. They finally became competitive after the mid-1890s as a result of French protective tariffs (that increased grain prices), French wine production recovery (decreasing wine prices), new agricultural practices and, as described by Offer (1991), the worldwide grain demand's outpacing of the supply (particularly since empty lands were fully colonized). Hence, although certainly other factors – i.e. the settlement process and type

[11] Similarly, in particular after 1983, the Algerian government has undertaken several plans to boost land development in the steppe and Sahara. For instance, in the 1983 Law (*Accès à la propriété foncière agricole par la mise en valeur*) the State granted "a private property right to any farmer who develops previously undeveloped public land in the Sahara or the steppe (former *arch* land)" (Daoudi and Colin, 2016, p. 5).

[12] As explained by Offer (1991), grain was the strategic commodity of the nineteenth century and it allowed classifying the world into two categories: wheat-importing countries, such as Great Britain, and wheat-exporting ones, such as Russia. A strategic commodity is defined by the author as "an article of trade whose denial can affect the well-being or even the survival of a great power. It does not have to dominate the balance of trade. Like petroleum today, it only has to form a link in the cycle of production and to have no adequate substitutes" (p. 83).

of colonial administration, the higher domestic demand caused by a growing population, the improved infrastructure network, and the development of an industrial agriculture – also help to explain the expansion of trade, the evolution of French and world market prices strongly determined the selection of the cultivated crop.

The international prices were determined in a trade environment that was changing rapidly during the years analyzed. Western European countries joined Britain in moving toward a free-trade regime during the 1850s and 1860s, leading to lower European average tariffs and a higher number of multilateral pro-trade deals (Federico, 2012; Tena-Junguito et al., 2012). The higher trade flows were favored by the transport revolution, a higher GDP growth rate associated to changes in demand patterns, and a relatively peaceful international environment (Williamson, 2011). Yet these trends in European markets were soon to be affected in the 1870s by the incoming grain flows from the new frontiers in Canada, Argentina, Australia, and Russia (Offer, 1991; O'Rourke and Williamson, 2001). The higher grain supply pushed European landowners' agricultural incomes downward so numerous countries returned to protectionism; France, which had initiated the path toward free trade with the Cobden-Chevalier treaty during the Second Empire, was one of them. This shift towards protectionism responded to mainly to rural French producers who demanded a higher level of protection in the 1880s, specifically on foreign grain and animals. These protectionist interests, mirrored in the 1885 and 1887 laws, finally triumphed in the *Méline* tariff law of January 11, 1892.

This shift towards protectionism went hand-in-hand with the French colonial tariff assimilation regime that secured a reciprocal and balanced commercial relation between France and Algeria and guaranteed an "absolute freedom of duties" (Girault, 1916, p. 262).[13] Indeed, the *Méline* tariff simultaneously established the assimilation policy given that, as Girault (1916, p. 82-83) explains, "the beaten free-trade party could not preserve commercial liberty in the colonies when it was incapable of maintaining it in France."[14] The assimilation policy had various effects. On the one side, in addition to the national sentiment attached to the colony, the French benefited from the extension of their internal market and their exports accounted for approximately 90 percent of Algerian imports. The same tariff regime in Algeria, on the other hand, simplified formalities (e.g. tariff classifications) and allowed producers to profit from the higher wine, wheat, and cattle prices generated by the French protectionist policies. Furthermore, although Algerian consumers paid prices as high as the ones found in France, they experienced relatively lower costs of living.[15] Overall, around 80 percent of Algeria's trade was free of duties

[13] With some minor exception due to indirect internal taxes. The policy of assimilation became one of the principal pillars of French colonial administration . It aimed to transform Algeria into an extension of French territory with direct rule from Paris. This policy established "the doctrine that the conqueror's civilization should be taught to the people of the conquered territories" (Leonard, 1962, p. 536), expecting to adapt French production methods, culture, and administration to Algeria. This policy became strongest in the 1870s and it is considered to have failed around the turn of the twentieth century (Lewis, 1962; Ageron, 1968).

[14] Although it is considered that the tariff assimilation policy began to manifest after 1883, the 1892 law is regarded as the ending point of the French liberal policies as it increased rights over both agricultural and industrial products. For instance, by 1894 the wheat tax had increased up to 32 percent (O'Rourke and Williamson, 2001).

[15] As a counterfactual, Girault (1916) explains that if Algeria had been provided tariff autonomy, then the loss

and the French market was sufficient to absorb Algeria's main agricultural products (Girault, 1916).

Algeria was the first colony to experience the assimilation policy and, in contrast to other French colonies like the Antilles or New Caledonia, the policy behaved as a tariff union with France.[16] The market integration set by this policy linked agricultural production to cereal and wine prices in France. These, as shown in Figure 1.3, followed opposite trends during the second half of the 1870s: while grain prices dropped as a result of the overseas grain inflows coming into European markets, wine prices became lucrative because of its lower production caused by the *phylloxera* vineyard aphid in Europe. Thus, in the 1880s the area devoted to viticulture grew significantly as opposed to cereal, which remained stagnant until 1900 (see Figure 1.4). These trends are visible in the following quote by the British Consul-General Playfair in the 1886 Algerian Trade and Finance report:[17]

> It seems impossible for any country at the present day to compete successfully with India in the production of wheat, so it is hardly surprising that no great progress in agriculture, pure and simple, can be reported. The hopes of the colony are now centred in vines, and immense efforts are being made to protect it from the ravages of the much dreaded phylloxera [...].

Nevertheless the situation reversed at the turn of the century. In the 1880s wine became less profitable as production recovered in France, while cereal began to be competitive by the end of the 1890s, thanks to the newly introduced agricultural techniques (in more detail in Chapter 3) and French protectionism (Ageron, 1991; Mollard, 1950; Yacono, 1993; Lützelschwab, 2000). This reversal is reflected in the following quote from the trade report by the British Vice-Consul Scratchley for the year 1900 regarding the Constantine region:[18]

> The yield was generally satisfactory. In barley the crop was sufficient to enable the producers to dispose 23,600 tons for shipment to France. Wheat to the amount of 12,000 tons was also shipped. [...] The question of how to get rid of wines is becoming serious in Algeria. The vineyards in France are now all replanted, and the probabilities are that the yield will be sufficient to supply the wants of a country.

Overall, based on Amin's (1966) estimates, between 1850 and 1910 the net annual cereal production growth rate was of 1.7 percent, while wine production experienced an annual 3 percent growth rate from the 1880s until 1910. Figure 1.6 displays the wine and wheat production per hectare between 1875 and First World War. During this period, both products ranked as the

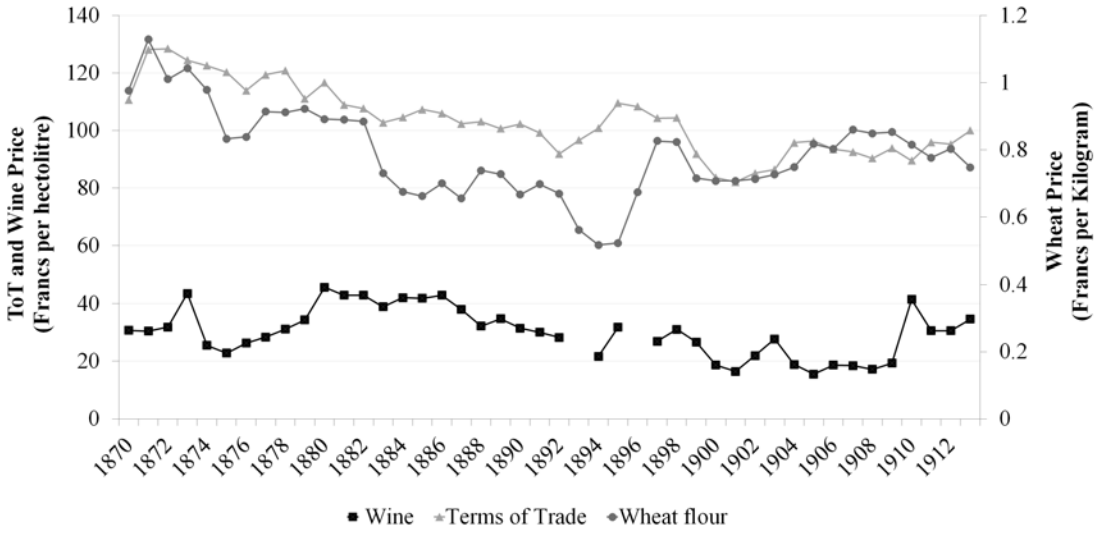
experienced by the Algerian consumer because of the increase in French prices would have been greater than the gains obtained from cheaper foreign imported products.

[16]However, it is not a complete tariff union as each of the countries keeps the revenue from customs and navigation duties obtained at the frontier.

[17]Foreign Office. 1888. Annual Series. No. 249. Diplomatic and Consular Reports on Trade and Finance. France. Report for the year 1886 on the commerce, navigation, and agriculture of Algeria. p. 9.

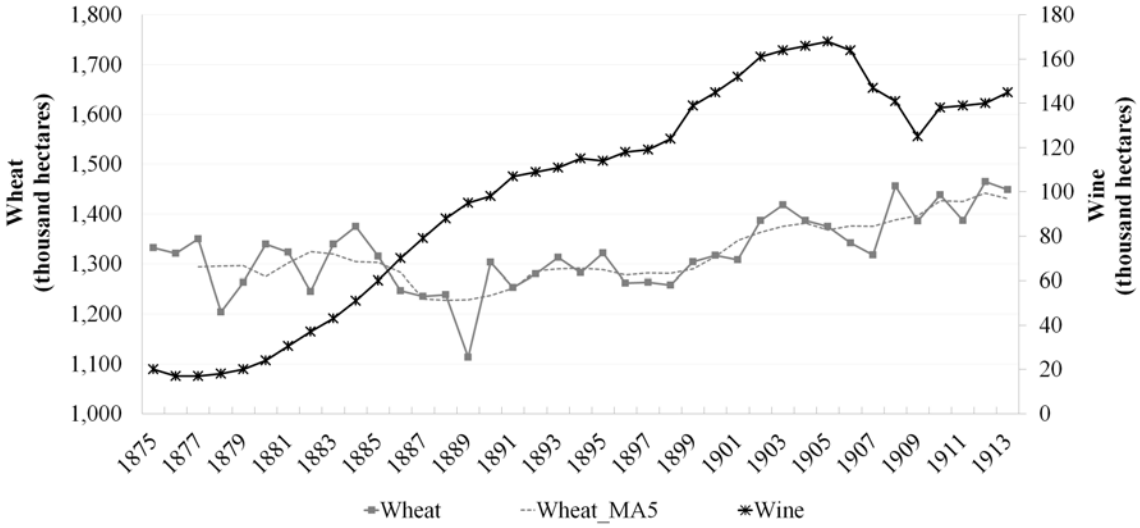
[18]No. 2710 Annual Series. Diplomatic and Consular Reports. France. Report of 1900 on the trade of Algeria. Reference to previous report, Annual Series No. 2472. p. 31.

Figure 1.3: Terms of Trade (ToT) and wine and wheat prices, French Algeria 1870-1913



This graph is based on Simpson (2011a) and Meloni and Swinnen (2014). The prices are deflated with Consumer Price Index (1914=100) from Mitchell (1994). The source for prices is Insee (1935). Terms of trade is the price of exports (free on board) divided by an import price index (cost, insurance, and freight); this series is courtesy of Tena-Junguito, A., and Federico, G., 2016. "World trade, 1800-1938: a new data-set," Working Papers 0093, European Historical Economics Society (EHES). See Appendix D for more detail on sources.

Figure 1.4: Cultivated area of wine and wheat in hectares, French Algeria 1875-1913



The series *Wheat_MA5* displays the 5-year moving average of the *Wheat* series. The figures refer to the cultivated area during the crop year ending the year indicated. The value for 1881 was interpolated for both production and area cultivated. *Source*: ASF, 1930. See Appendix D for more detail on sources.

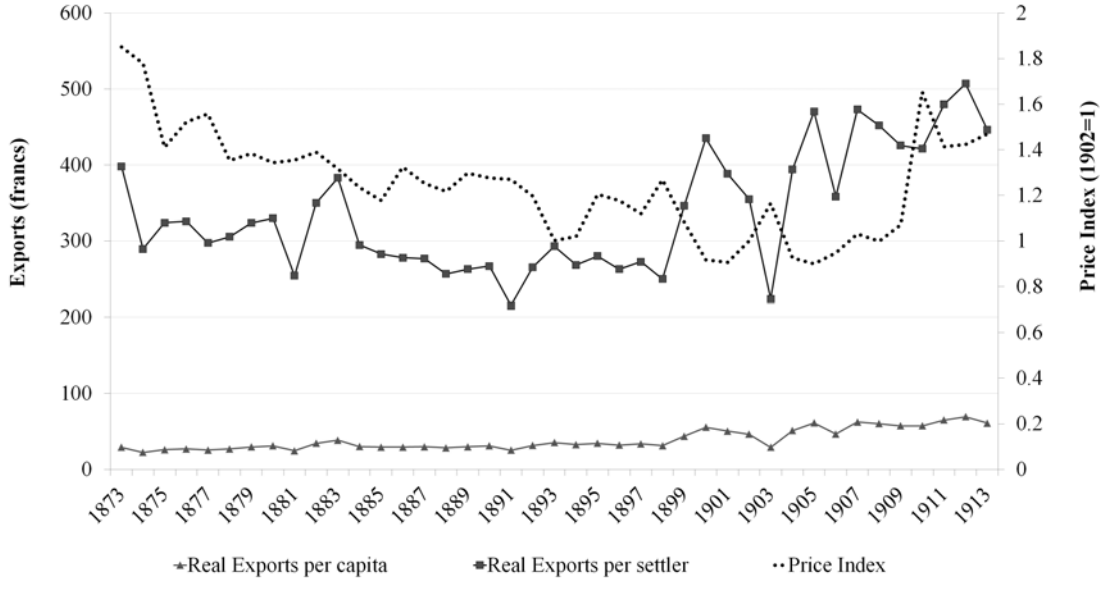
most important exports of Algeria in terms of their value within French statistical yearbooks. The export data obtained from these yearbooks and the output estimates reported in Mitchell (1994) suggest that the exported share of the total wine production passed from 40 percent in 1887, to 80 percent in 1899, and 70 percent in 1909, while the share of the cereal exports over the total production ranged between 10 to 15 percent. Based on Amin's (1966) estimates, the exported proportion of all the agricultural and mining production in 1880 was 33 percent and rose to 40 percent in 1910. Figure 1.5, which demonstrates the evolution of a representative

basket of real exports per capita,[19] per settler,[20] and the corresponding price index,[21] shows the persistent growth rate achieved by the real exports per settler at the end of the 1880s.

These figure were accompanied by a change in the terms of trade trend at the turn of the century as reflected in Figure 1.3. French colonial records display the highest trade figures after the 1890s and were characterized by a change in the composition of the export basket. This is reflected in Figure 1.7, where the darker regions that account for wine and cereal related products show a turning point towards a lower diversification after the 1900s which,[22] according to Ageron (1991), "condemned" the country's economic development:

> Given over to cash crops for wholesale export, to the point at which 50 percent of the country's exports earnings came from wine and its related products, agricultural colonization enriched European Algeria but lost all colonial justification. It restricted the growth of French population while competing in the market with metropolitan producers. Algerians themselves criticized it for sacrificing food-crops and condemning the country to the risks of monoculture (Ageron, 1991, p. 62)

Figure 1.5: Export basket and price index, 1873-1913



The price index accounts for the prices of the principal exports (cereal, wine, and livestock) weighted by their share over total exports. These are import values after the evaluations of the Commission at customs. *Source*: Insee (1930), Insee (1966), and Mitchell (1994). See Section "Trade and Population" in Appendix D for detail on methodology and sources used to obtain real exports per capita, real exports per settler, and the price index.

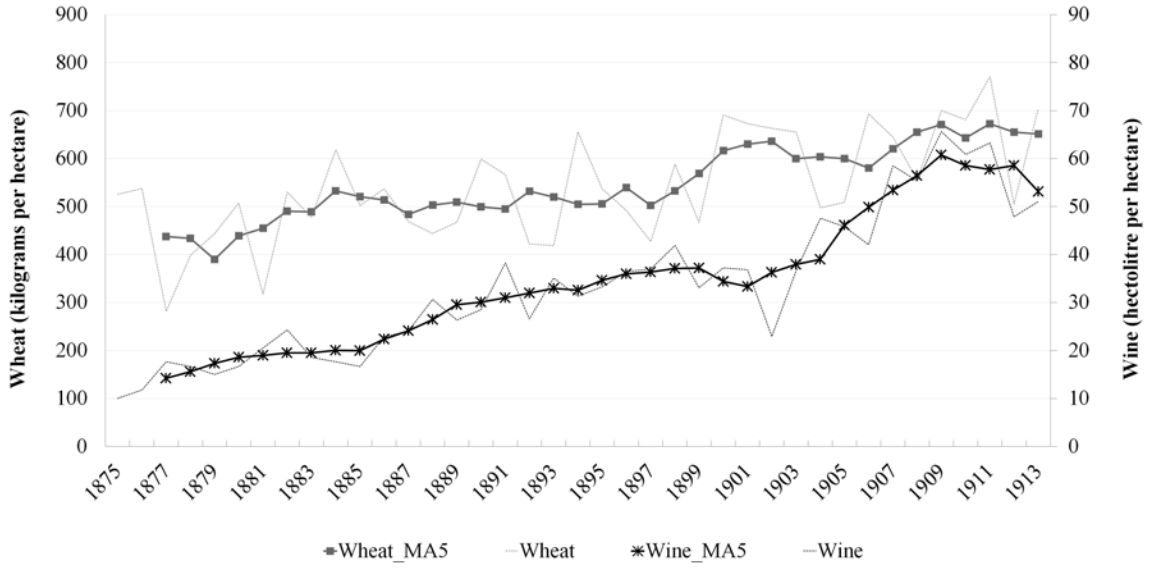
[19] That is, the total real exports divided by the sum of the settler and indigenous population (proxied by the Muslim and non-Muslim population).

[20] That is, the total real exports divided by the settler population (proxied by the non-Muslim population).

[21] The price index is constructed using the prices (base 1902=1) of the three principal exported products (wine, wheat, and livestock) and weighs them according to their annual total export share. The exports series have been obtained from numerous *Annuaire Statistique de la France* and Mitchell (1994), and are calculated dividing the amount of total exports by the price index. Ultimately, dividing real exports by both the total population series and the number of settlers shows the per capita trends. See Appendix D for more detail on sources.

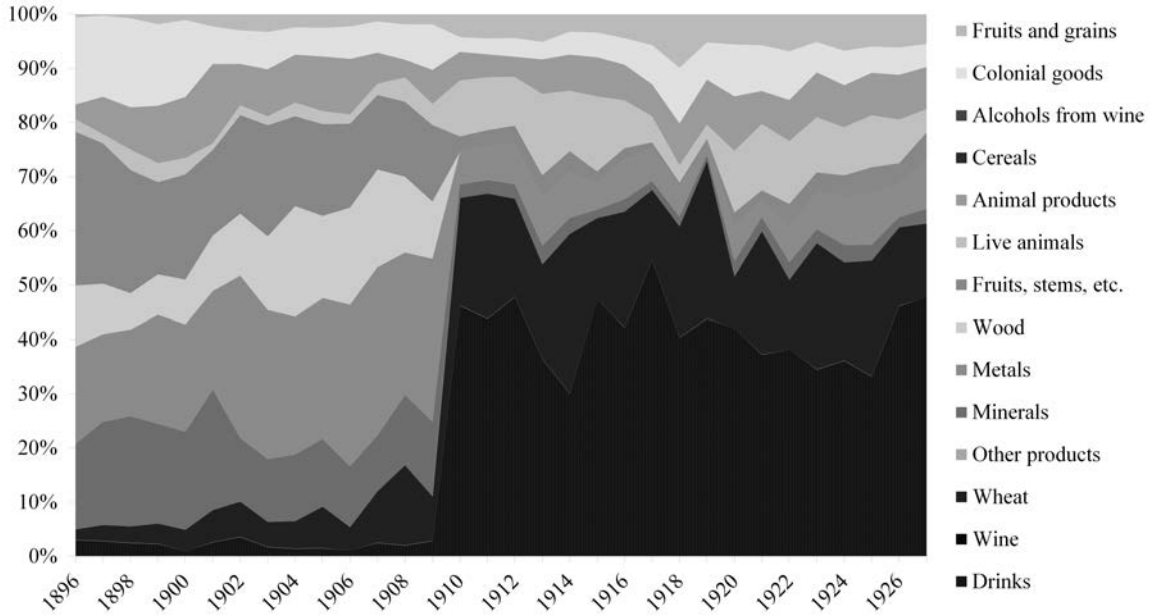
[22] The categorization of products in the original source (ASF) is more complicated than the one shown in Figure 1.7, but exceeds the reach of this dissertation and therefore shall not be examined in greater depth.

Figure 1.6: Production of wine and wheat per hectare, French Algeria 1875-1913



The series *Wheat_MA5* is the 5-year moving average of the *Wheat* series. *Wine_MA5* displays the 5-year moving average of the *Wine* series. *Source*: Insee (1930). The production values correspond to the crop year ending in the year indicated. See Section "Trade and Population" in Appendix D for detail on methodology and sources used to obtain the real exports per capita, real exports per settler, and the price index.

Figure 1.7: Export diversification, French Algeria 1896-1926



For convenience, each export category aggregates more complicated disaggregated groups. The cereal category excludes wheat. See Section "Trade and Population" in Appendix D for detail on methodology and sources used to obtain the real exports per capita, real exports per settler, and the price index.

An Overview of Constantine

Algeria's topographical regions change significantly from north to south, shifting from coastal mountains with river valleys in the north, through the interior Tell Atlas mountains and the High Plateaux steppes, to the Saharan Tell mountain system that limits the Sahara desert in the south. This study analyzes Constantine, a former French department (between 1848 and 1962) situated in the northeastern part of the country, and described as hillier, colder, rainier, and with soils enriched with potassium and phosphates.[23] The fertility provided by these minerals permitted the specialization of many holdings in cereal cultivation. However, climate variability and strong regional differences in soils – changing from fertile river valleys in the coastal regions of Béjaïa (formerly Bougie) and Annaba (Bône), to extensive grasslands in the High Plateaux in the proximities of Sétif, and arid and rocky regions towards the Sahara – have traditionally led populations to combine diverse agricultural lifestyles (McDougall, 2017).

Recently, in his book "A History of Algeria," McDougall (2017) explains that, during the Ottoman Regency (i.e., 1515 to 1830), "the region's [in Constantine's] optimum ecology [...] relied on extensive agriculture with a light plough on large, open fields – where they were available – combined with livestock-raising, with flocks of herds being moved seasonally by populations who often combined settled agriculture with a degree of mobile pastoralism." According to the author, prior to French settlement, about 90 percent of Algerian society was rural and agricultural and pastoral production generated a surplus that was collected by the state. What is more, "cereal culture supported by the soils and rainfall of the eastern region, along with intensive agriculture in the well-watered mountains, has historically supported higher population levels – up to half of the country's total population – and a greater agricultural surplus than other areas."[24] This was particularly the case in the Kabylia region, a densely populated historic region situated in the coastal Tell Atlas mountains and mostly inhabited by Berbers (Kateb, 2001; McDougall, 2017).

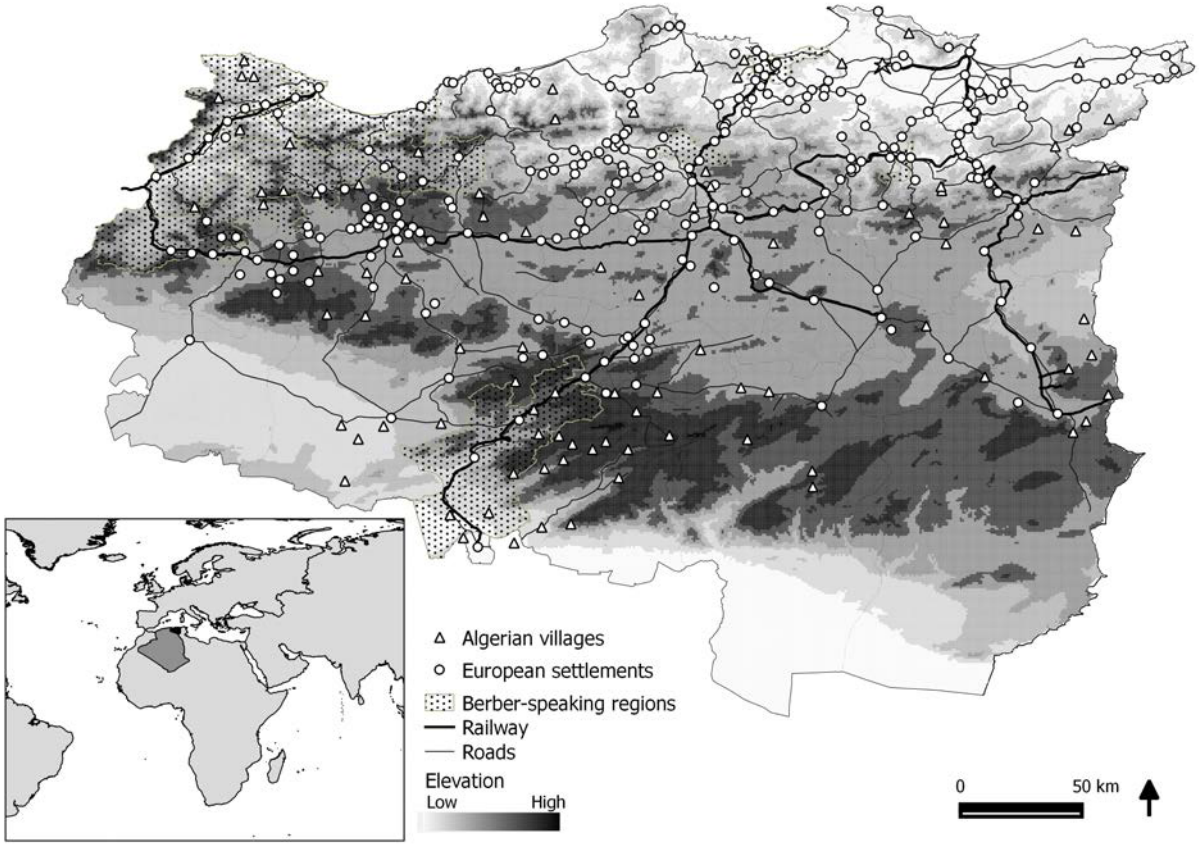
The land tenure system during the Ottoman Regency was complex,[25] mainly because communal interests and usufructuary rights played an important role. The most fertile land was owned by the state (known as *beylik*) and part of it was assigned – usually in exchange for provisions or military and civil service – to government officials (*apanage*), and part to sharecroppers

[23] For aerial photography see D.1 in Appendix D.

[24] For further detail on the Algerian economy, society, and institutions established prior to French occupation, see Bennoune (2002); McDougall (2017); Yacono (1993); Ruedy (1967); Nouschi (1961).

[25] For simplification and in line with most authors, I describe the three main categories mostly cited in the literature. For further detail I recommend Ruedy (1967) in general, and Nouschi (1961) for Constantine. However, the existent literature on Algerian land tenure prior to French colonialism is confusing and the definitions of land tenures often do not coincide between authors.

Figure 1.8: Map of Constantine at the beginning of the 1900s



In the original map the Algerian villages are reported as "*Bordj, Villages indigènes*" and European settlements are classified as "*Centres de colonisation*" and "*Fermes, Hameaux*." The regions are dotted if the Kabylia or Berber-speaking population density over the number of owned-hectares is above the value of one in 1904/05. The roads include "*Routes nationales*," "*Chemins de Grande Communication*," and "*Chemins d'intérêt commun*." *Sources*: SA (1904/05), Busson (1898), and ANOM-iREL; Maps: CEPC (1883) and CVC (1902); GIS data: CGIAR-CSI (2006). For more detail on spatial aggregation, sources, and the construction of variables see Appendix D.

(*khāmisāt*),[26] tribes (*azl*),[27] and *corvées* (*tuwīza*).[28] Within the *beylik* land, some authors have also included the *habous* land, which was inalienable land assigned to an organization related to charity, religious, or civic works; however, it was not extensive and was mostly limited to urban areas (Ruedy, 1967). The tribal *arsh* land – the one most targeted by the colonial administration – was communally held and transmitted by lineage, although each family unit had access to individual plots of land (depending on the family's inheritance and the number of male laborers

[26]The traditional indigenous sector was mostly farmed under small landholdings that were usually sub-rented to sharecroppers known as *métayer* or *khammès*. They cultivated the land in exchange for one-fifth of the final production. This ratio was calculated based on the number of inputs provided by the sharecropper for production (usually it was only labor and the landowner provided the remaining five: land, water, seeds, animal power, and labor (Griffin, 1976).

[27]The *azl* was extensive land cultivated by tribes in exchange for a regular payment and was particularly relevant in Constantine. Bennoune (2002, p. 21) explains that the tribe formed "the basic socio-political and economic unit, was sub-divided structurally into several agnatic lineages, composed of numerous interrelated nuclear or extended corporate families. A patriarch was the undisputed head of every household. The size of the tribe varied from a small cluster of hamlets dotting one or two mountain slopes to an immense unit occupying a wide region" (the original source is: Hart, D. (1972), The tribe in modern Morocco: two case studies, in *Arabs and Berbers*, Gellner and Micaud, Lexington Books, 1972)

[28]This was a form of unpaid labor which the governor (*bey*) relied on for cultivation.

in the family).[29] Finally, *milk* land – regarded by the French as the equivalent to European private property – could be privately sold (although sales were uncommon and required numerous legal formalities) and was enclosed by stone walls, hillsides, or hedges. This type of land was mostly located in the Kabylia and linked to intensive agriculture (e.g., arboriculture and vegetables).[30]

Thus, the existent land property structure in Algeria was complex and required the colonial administration to undertake a series of institutional measures in order to increase its public domain. The first measures focused on land appropriation, while the following ones (in particular, after the 1860s) aimed at privatizing property and establishing a land market. Chapter 2 focuses on the the latter, describing the "legal" measures in the form of property decrees and laws – specifically, the 1863 *sénatus-consulte*, the 1873 Warnier law, and the "little" *sénatus-consulte* of 1887 – developed by the colonial administration to encourage private property transactions between Algerians and settlers. For example, the 1863 *sénatus consulte* law, in order to disintegrate tribal areas and divide them into territorial units known as *douars*, delimited and registered indigenous properties and provided legal land titles in accordance to French law (Bellahsene, 2006, p. 169) (see Figure D.3 in Appendix D).[31]

However, prior to these measures and soon after conquest,[32] the French colonial administration seized land in various ways. As described by Ruedy (2005), it first declared itself to be the owner by right of conquest of *beylik* lands and their dependencies, appropriating by 1851 around 158,000 hectares. By the 1850s it had seized 17,414 hectares of *habous* lands and, as a form of retaliation on indigenous insurrections and regime opponents, it "sequestered" up to 49.007 hectares of tribal land (*makhzan* and *arsh*).[33] It confiscated land considered to be uncultivated and by 1851 it had appropriated 52,274 hectares declared as vacant (as many owners left the lands after war and others were unable to verify their property titles). Finally, in the 1850s, the colonial administration, with no legal basis, provided land to settlers by means of dispossessing and circumscribing tribes to restricted areas (Lützelschwab, 2013). This policy was known as *cantonnement* and it appropriated a total of 63,901 hectares by 1851 (Ruedy, 2005). In addition, the failure of "the last massive armed revolt" in the Kabylia in 1871 provided the public domain a major source of land in the eastern part of Algeria, confiscating up to 574,000 hectares by 1875

[29] Ruedy (1967, p. 11) explains that *arsh* land was "one of the most delicate and controversial problems encountered by the French in Algeria." The occupying tribes had no right to transfer ownership and did not own property titles, but they did possess "(1) the right to occupy and cultivate the lands; (2) the right to enjoy its fruits; and (3) the right to transmit it to direct male heirs. As long as the occupant remained on the land and paid the kharāj [a colonial tax], he could not legally be evicted." This land was frequently mistaken for collective property but "each family cultivated a fixed parcel in its own right and could pass it on, as we have seen, to heirs in the direct male line. The periodic redistribution of lands characteristic of true collective ownership was not resorted to." Only *Mawāt* lands were similar to collective property and these were devoted mainly to pasture.

[30] However, part of the *Milk* was also communally held, particularly the cereal growing and pasture land sections.

[31] The *douars* were municipally self-governing territorial units. Each one had a council of notables named *djêema* formed by 6 to 16 members (not elected up until 1919) and it was presided by a Caïd who was appointed by the French government and proposed by the colonial administrators of its corresponding *commune mixte* (Sivak, 2008).

[32] The 17th of July of 1830 a *Comité des Domaines* was established to regulate property records and set the legal means to develop a land market (Sivak, 2008, p. 68).

[33] Sequestration was a type of circumstantial, massive expropriation which became a systematic method used by the administration to obtain land (Bellahsene, 2006, p. 283).

(Ruedy, 2005, p. 76).[34] Table 1.1 displays the land categories and appropriation methods used by the French state in Constantine.

Table 1.1: Summary of domain properties, by category of land or method of acquisition, bound over to colonization (1830-1851) in hectares

Constantine	Beylik	Sequest.	Habous	Expropr.	*Cantonnement*		Vacant	Exchange	Heirless	Misc.	Total
					Arsh	Makhzan					
Bône	161		4,142	266				329		977	5,875
Bougie	44	109	4								157
Constantine	35,372	1,162	4,627		2,195			303			43,659
Guelma	11,463				781					1	12,245
La Calle	97										97
Philippeville	27,782					16,000					43,782
Sétif	680										680
Total	75,599	1,271	8,773	266	2,976			632		978	106,495

Source: Ruedy (1967, p. 100).

Following this, in order to become the rightful owner of a plot of land, a settler had to apply through the colonial administration. This brings us to an explanation that is key to understand the settlement process in Algeria:

> Until 1871, the state, master of an ever-expanding public domain in rural properties, was the principal intermediary in transferring Algerian land to Europeans; from the 1870s onward, changes in land legislation facilitated direct acquisition from Algerians and made this as important vehicle as the domain transfer (Ruedy, 2005, p. 70).

The year 1870 therefore marks the shift between two colonial administrations with very different land policies: from a military one that strictly regulated settlement, to a civil one that favored regional expansion. Thus, as a matter of convenience and to simplify the empirical framework in this dissertation, I will refer to the regions settled prior the 1870s as "older," and the ones settled after as "frontier."

However, despite the different land policies, both administrations shared the same land settlement strategy: the creation of *centres de peuplement* – also known as "settlement centers," "population centers," or "colonization centers" indistinctly – where settlers would live and cultivate their lands. As explained by Bellahsene (2006),[35] a settlement center was a territorial unit founded solely for rural settlement. It was the final project per se, and was not initially intended to become a town or a village devoted to commercial exchange, nor endowed with relevant administrative and economic functions. According to the author, this foundational "rural" idea – that is, that economic activity evolved entirely around agricultural production – changed

[34] The Kabylia revolt was explained by many factors but the most significant, or at least the most frequently cited one by historians, is the widespread Algerian discontent resulting from successive years of crop failures, drought, and epidemics, together with the arrival in 1870 of the new colonial civil administration that favored regional expansion of settlement.

[35] In his dissertation "*La colonisation en Algérie: Processus et procédures de création des centres de peuplement. Institutions, intervenants et outils*" the author studies the process and procedure of creation of the population centers in detail.

into a more "urban" type in 1919, when official colonization had ended, the cultivable land was exhausted, and the transport infrastructure had developed. Yet, before the end of official colonization, territorial expansion by means of establishing new centers was prioritized over the enlargement of centers already built. In addition, the plots granted were conditional to their cultivation; for instance, as Sessions (2015, p. 249) describes,

> The foundational decree of September 1836 required that each concessionaire build a house, enclose his land with a protective ditch or hedge, and clear and sow one-third of the arable land each year until the entire concession had been "cultivated," meaning the natural meadowland had been cleared and occupied no more than a quarter of the concession's total area. The concessionaire was obliged to plant fifty trees per hectare, to drain any wetlands, and to allow the public works department to extract sand and stone from uncultivated areas. If the grantee agreed to make additional expenditures on buildings and other improvement beyond these minimum requirements, the three-lot limit could be suspended. Only upon completion of these contractual requirements did the concession become definitive.

The basic structure of a settlement center was a "colonization perimeter" circumscribing a village in the center, designed exclusively to provide accommodation for families, and the to-be-cultivated plots of land were located at a maximum of one-hour distance from the village.[36] It was a permanent accommodation for settlers that also functioned as an instrument to secure land and consolidate colonialism, particularly in the areas where the majority of population was indigenous. Overall, as Bellahsene (2006) describes, although the program was initiated in the 1840s, the real boom began at the beginning of the 1870s with the arrival of the civil administration, creating around 474 centers on 705,196 hectares (out of which more than 50 percent was obtained from the Kabylia insurrection in the 1870s).

French colonialism had severe effects on the Algerian population, particularly given that the colonial administration targeted the internal structures of rural populations with measures such as *cantonnement*, the creation of settlement centers, the privatization of collectively held and communal lands, and the design and implementation of territorial units known as *douars* (Kateb, 2001). Overall, the Algerian population experienced strong declines after French occupation, in particular during *les années terribles* in the 1860s as a result of economic and demographic crises caused by epidemics (cholera twice, typhus, and smallpox), drought, famine, and the major rebellion in the Kabylia region (Yacono, 1993, p. 169). It achieved positive and steady growth rates only after the insurrection in the 1870s. The conflict affected around three quarters of Constantine's indigenous population and had ruined many small rural owners (*fellahs*) (Nouschi, 1961). However, although the 1870s also marked the beginning of a period of relative calm, the Algerian population experienced the start of an economic model that led to a deterioration of the Algerian economy, particularly in the rural areas: "due to the increase in tax burden [...], to

[36] This corresponds to a maximum of 5 kilometers, assuming an average walking speed of 5 km per hour.

steady and catastrophic loss of land, and to insertion of native agriculture into a market economy dominated by the Europeans" (Ruedy, 2005, p. 94).

Sources and spatial dataset construction

Note on Terminology

There is no settled consensus on the correct terminology used to refer to local population in Algeria prior to French colonialism.[37] The colonial statistical sources that I have used in this study tend to categorize the population groups in "Europeans" and "*indigènes*." However, in the case of Algeria, the word "indigenous" recalls the pejorative term "*indigènes*" while in English the word "native" is also quite fraught as it replicates colonial vocabulary. In addition, the term "Algerian" may also cause confusion as many settlers called themselves "Algerians" after decades of settlement; as Albert Camus stated in a press conference in 1958, "the Algerian French are likewise, and in the strongest meaning of the word, natives."[38] Finally, the colonial demographic statistics often report the data classifying the population in "non-Muslims" and "Muslims." Good (1961, p. 3) explains that the non-Muslim group includes "French citizens born in Algeria or elsewhere in the French Union, Algerian Jews (established there since Roman times and recognized as French citizens since the Crémieux decrees of 1870), naturalized and alien immigrants from other European countries (notably Spain, Italy, Malta, Turkey), and those Moslems who, having renounced their special status, are no longer subject to Koranic law. The Moslems [. . .] include two main linguistic groups, in the proportion of one to four. The smaller group speaks Berber, an ancient language without a written alphabet. The other speaks Arabic."[39]

It has been suggested that I categorize the groups in "Algerians" on the one hand, and "French Algerians,""settlers," or "Europeans" on the other hand. Yet, in my opinion, in this dissertation – which contains a relevant part of quantitative and comparative analysis – using this terminology is confusing. Thus, I will mostly use for simplification the term "indigenous" when referring to the populations already located in Algeria prior to French settlement; however, when the context seems clear enough, I will use the term "Algerians." In addition, to simplify, I will consider the "Muslim" group, when available, as a proxy to the "indigenous" or "Algerians." With respect to the "settler" population, I will use "Europeans" or "French Algerians" indistinctly and, when necessary, it will be proxied with the "non-Muslim" population.

[37] I am grateful to Peter Von Sivers and James McDougall for their helpful suggestions regarding the terminology to be used.

[38] I found this quote in D. Prochaska's introduction to his book "Making Algeria French: Colonialism in Bône, 1870-1920" published in 1990.

[39] Good (1961) categorizes both groups based on the *Institut National de la Statistique et des Etudes Economiques* and the *Ministere de la France d'Outre Mer. Service des Statistiques d'Outre-Mer. Les recensements demographiques dans les pays d'outre-mer (etude methodologique). Bulletin Mensuel de Statistique d'Outre-Mer, Supplement Serie Etudes, No. 35, Jan. 1957. Paris, 1956. p. 162* and *Service de Statistique Generale. Resultats statistiques du recensement de la population du 31 octobre 1954. Vol. II. Sexe, age, etat matrimonial, lieu de naissance, instruction. Alger [1959]. p. 151. Tables XII and XIV.*

With regards to the administrative organization, I will always refer to the regional boundaries existent in Constantine during the colonial years; more specifically, between 1870 and prior to the territorial changes undertaken after 1955. The following section provides more detail on the territorial administrative division present in French Algeria during the years analyzed, and Table D.3 in Appendix D shows the list of *communes* or municipalities (and their actual corresponding *wilaya* or province) that have changed their names after Independence in 1962 (for example, colonial Philippeville is now Skikda and Bône is Annaba).

Sources and territorial coverage

The first two chapters in this thesis will use data at the municipal level (or *commune*) for the years 1904/05 and 1913/14.[40] This data is located in the colonial archives in Aix-en-Provence (see Appendix D for more detail) and comes from annual agricultural statistics reported by the French colonial administration in Constantine, the largest of the three departments in Algeria.[41]

With regards to the territorial coverage, this study is limited to the "pacified" areas under French civil administration and does not include military territories such as the Southern territories or "*Territoires du Sud*" (that is, the Sahara regions). At present, Algeria covers 2,381,741 square kilometers, of which almost 90 percent is the Sahara desert. French Algeria, which lasted from 1830 to 1962, was limited to the northern fertile regions; as Ruedy (2005, p. 5) explains, "the heart of historical Algeria is a band of valleys, mountains, and plains extending roughly three hundred kilometers inland from the Mediterranean." By 1848 the northern part of Algeria was entirely controlled by the French and was divided into civil and military territory and, as settlement consolidated, the regions under military administration shifted towards the civil one. However, the areas in the Sahara (classified as "*Territoires du Sud*") were maintained under the military administration up to 1956.[42] According to the *Tableau Général des Communes* (henceforth, TGdC), at the beginning of the 1900s the civil territory covered a total of 130,880 hectares, of which 50 percent (about 62,086 square kilometers) belonged to Constantine.[43] Thus, although Algeria is currently the tenth-largest country in the world, in the 1900 only a 5.5 percent of it was under the French civil administration (20 percent including the regions under military administration) and Constantine accounted for almost 3 percent of the current area.

In 1848 Northern Algeria was divided into *départements*, which were then subdivided into *arrondissements* (districts) – in Constantine, these were Constantine, Batna, Bône, Bougie, Guelma, Philippeville, and Sétif – and *communes* (which I will refer to as municipalities). The latter were subsequently divided into *communes de plein exercice* (henceforth, CPE), *communes mixtes* (CM), and *communes indigènes* (CI). This study exclusively covers the CPE and CM as these were the ones controlled by France in the Northern part of Algeria during the years

[40] They are partly available also for 1906/1907. Regarding viticulture and cereal production there is additional data for the campaign of 1900/1901.

[41] The other two are Alger and Oran, which were created in 1848, modified in 1957, and disappeared in 1962.

[42] This information was obtained from the ANOM-iREL online search engine. See Appendix D for more detail.

[43] The military territory in Constantine covered 129,661 square kilometers.

analyzed.[44] The majority of settlers located in the CPE, which were the municipalities in which the colonial administration was elected and under French civil law, whereas in the CM the majority of the population was indigenous, the colonial *Administrateur* was chosen by the general government, and they were under Islamic law. The latter, which were projected to be future CPE, were mainly tribal areas and *douars*; they included military posts, and were regions with no (or very few) settlers and only a few of them were beginning to engage in commercial or industrial activities.

These statistics allow us the study of around one hundred municipalities prior to the 1957 territorial reform.[45] It is a unique spatial dataset since it accounts for both cereal and viticulture production for each commune, differentiating by ethnic group. There is data on area cultivated, production, type of equipment (number of machines according to horsepower, type of plow, etc.), and agricultural construction used (e.g. steam mills, water mills, etc.). The agricultural population can be analyzed according to nationalities and land tenure categories (owners, farmers, sharecroppers, or laborers), and there is information on the distribution of cultivated and non-cultivated land according to owner category (state property, public domain, communal forests, etc.).[46] There is data on the number of agricultural properties based on their size in hectares (below 10, 11-20, 21-30, 31-40, 41-100 and more than 100 hectares), and area distribution based on nationality and cultivation method (*à la mode Européenne* or *à la mode Indigène*). Regarding labor markets, there is data on the number of workers(resident and non-resident within the municipality), days worked, average price per day, and value of salary paid (*journées agricoles*) for both the settler and indigenous populations.

Chapter 4, unlike the other two chapters, uses population data reported at a lower unit of observation than that of municipalities. It is subdivided into settlement centers (*centres*), plots of land (*fermes*), tribal areas or fractions, and *douars* (i.e.,the tribal areas to which the *sénatus-consulte* had been applied). It is obtained from the TGdC for the years 1884, 1892, and 1897 (see Appendix D for details). These statistics were published by the General Government of Algeria (henceforth, GGA). They provide information on population densities and cover both civil and military territory.[47] The General Governor was in charge of providing yearly statistical information to the French Parliament on the colony's progress. He also indicated to the prefects how to adapt the Algerian statistics to the French data-collection system (Kateb, 2004). However, Algeria was very different, in particular with regards to the presence of nomadic populations.[48]

[44]The TGdC (1902) reports that within the civil territory, a 20 percent were CPE (24,026 square kilometers), of which the 7,500 square kilometers were in Alger, 7,225 in Oran, and 9,301 in Constantine. The rest of the civil territory (aprox. 80 percent) were CM, which occupied a total of 106,853 square kilometers, of which 24,354 were in Alger, 29,714 in Oran, and 52,785 in Constantine. The military territory (34,809,113), not included in the analysis, was divided in CM with a total of 5,827,961 square kilometers and CI with 28,981,152.

[45]The final sample is limited to one hundred observations for each year after having homogenized the data to match observations between both periods.

[46]Information is also provided on quantity of land cleared, cost of clearing, and value of cleared and non-cleared land. It includes data on farm animals and derived products with ample detail on each group.

[47]The 1884 volume reflects the state of the population situation in the 30th of September. The 1892 and 1897 volumes reflect it in the 1st of January for the corresponding years.

[48]Griffin (1976) explains that in Algeria, in addition to the sedentary indigenous rural owner or *fellah*, there were

Thus, the applied census technique changed according to the surveyed population category. More specifically, populations in the civil territory and those located in the settlement centers in the military territory completed a family questionnaire, while the populations in the tribal areas within the military territory were inferred by counting the number of tents (assuming that each tent hosted five to seven people). This is why the regions and data used in this study are limited to the civil territory, and thus the results are less affected by the differences in data-collection methodology.

Spatial Dataset Construction

By using Geographic Information System (GIS) software, I have aggregated and adapted Constantine's current administrative boundaries into those established at the beginning of the 1900s. This allows to match geographic information to the data obtained from the colonial agricultural statistics. In addition, the software provides spatial reference, permits the calculation of distances and the spatial relation of variables. To match the data from the colonial agricultural statistics to the geographic data, I georeferenced the historic maps with the actual post-Independence administrative boundaries (in other words, I overlaid the historic maps on the actual boundaries). The Appendix D specifies the details on the aggregation and changes of the current municipalities. The old pre-Independence boundaries were identified in various historic maps: i. a 1902 colonization map, ii. a 1902 transportation map, iii. a 1939 administrative map, and iv. a 1949 administrative map. Indeed, although the 1939 and 1949 maps are posterior to the period analyzed, they often provide more clear information. For instance, they display different colors according to the type of boundaries (e.g., settlement centers and *douars*). Using posterior maps does not affect the results given that the boundaries between 1902 and 1949 are almost identical; this is because the major territorial administrative reform undertaken after Algeria's annexation to France in 1848 – dividing the country in three provinces (Alger, Oran, and Constantine – was in the second half of the 1950s.[49] Thus, the final boundaries analyzed in this thesis are those of 1902.

the semi-nomads and nomads. Among the semi-nomads, a portion moved continuously from one area to the next depending on available pasture, while others changed from a summer camp to a winter camp. Yet they did not move from their tribal area and thus should not affect my analysis, as my unit of observation is the tribal unit. However, the nomads did leave the tribal areas: in spring they moved from the southern regions in the Sahara to the north, and returned in October.

[49] Some southern territories such as Tébessa or Khenchela did experience territorial modifications between 1902 and 1949 but these are excluded from the analysis.

Chapter 2

The Crowding-Out of Small Family Farm Settlers

Abstract

This chapter examines the Constantine region in French colonial Algeria at the beginning of the 1900s, to study the relation between agricultural settler density, considered to be the outcome of the French rural settlement failure, and the property size distribution at a municipality level. The agrarian structure, which departed from the initial "small-settlement economy" goal, associates a lower degree of population settler density to higher levels of land concentration, confirming the hypothesis of land amalgamation as the cause of the crowding-out of small family farm settlers. It argues that the institutional land size restrictions, which in the nineteenth century limited property size expansion by means of granting small plots of land, had a progressively weaker direct influence on settlement as a response to land aridity, allowing for the presence of larger properties in the frontier or later settled regions. Results show that the presence of the road network played an important role as well, having a positive effect on the rural settlers and hindering land concentration. Finally, the results suggest that regions endowed with higher levels of settler family farms positively linked to a greater degree of indigenous agency.

2.1 Introduction

Historians of French colonial Algeria often argue that the French government's experiment to establish a rural family farming settler economy failed. The goal of the French government from the beginning was to create a settler economy by gradually increasing the European rural population. Through official colonization (i.e. organized by the colonial administration), it aspired to expand rural settlement by means of migration waves and granting small plots of land conditional on obligatory residence. The idea was to form a "peasant's paradise, a prolongation of France across the Mediterranean where myriads of French settlers would make the Tell bloom with small farms and cosy villages, as in the western provinces of the homeland" (Roberts, 1963, p. 215).[1] Yet, what initially was expected to be a peasant rural society of small family farm landholdings resulted in a speculative cash crop production colony based on relatively large estates devoted to wheat and wine. As stated by Charles-Robert Ageron, these large-landholdings known as a *latifundia* system, forced out and discouraged rural settlers, formally ending the rural settlement organized by the colonial administration:

> What had in fact been happenning from a very early date was the amalgamation of small properties, little farms which were economically doomed in a country geographically favourable to *latifundia* or great estates, and now given over to speculative crops for the export market. In the process, the settlers themselves had been squeezed out (Ageron, 1991, p. 61).

Indeed, the recorded history of French Algeria frequently mentions that the colonial administration failed to create a family farm economy and achieve a significant rural settler population growth. Roberts (1963, p. 229) stated that "French settlement in Algeria cannot thus be termed a success," while Amin (1970, p. 32) asserted that the decrease of rural European population with respect to the total, the crowding out of small-settlers in favor of big land-owners, and the agricultural production stagnation after the 1930's are all factors that allow its classification as a "failure." Ageron (1991, p. 61) holds that evidence of this failure was the withdrawal of official colonization motivated by the stagnation of the rural European population between 1906 and 1926 (Ageron, 1991). More recently, Sessions (2015, p. 210) argues that beyond the debate on who was to blame, French officials and commentators coincided in that "there was no question about Europeans who failed to cultivate the lands they had acquired." As shown in the demographic statistics in Table 2.1, with regards to expansion of rural settlers, although the absolute figures doubled between 1872 and 1893, the failure was visible in relative terms in the following years; in 1893, 41 percent of the total European population was rural; a figure that fell to 39 percent in 1900, then dropped to 35 percent in 1911, and by 1948 was down to 22 percent.[2] In addition, contrary to what the colonial administration had hoped for, the number of

[1] The term "Tell" refers to the Tellian Atlas, a part of a wider mountain chain (Atlas mountain) located between the Mediterranean and the Sahara.

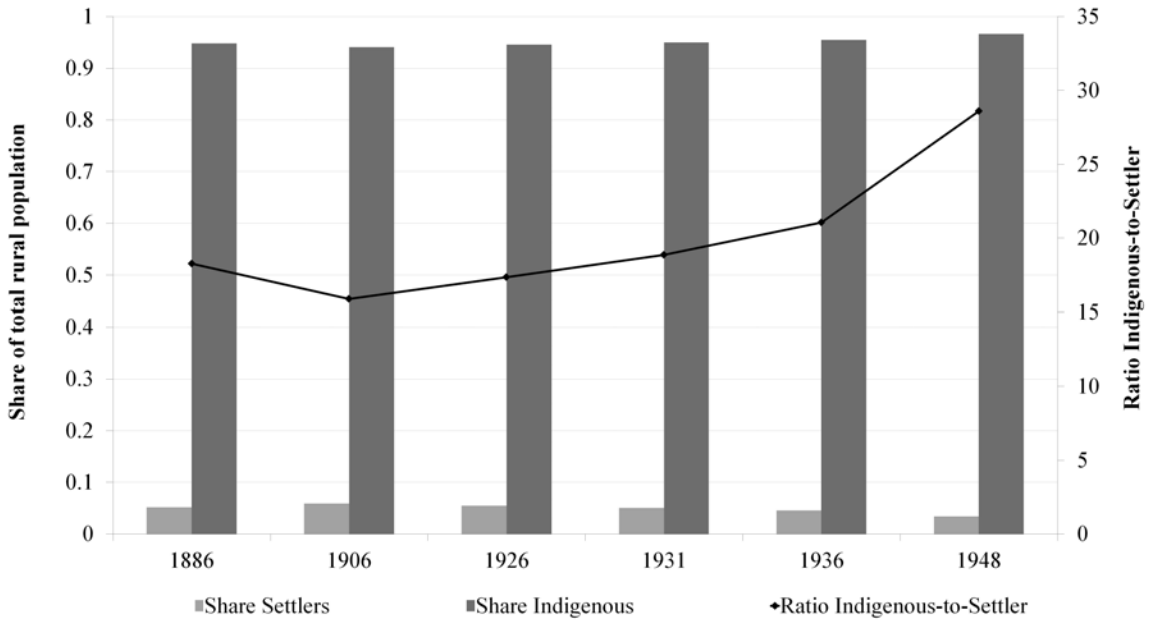
[2] From Ruedy (2005), based on Ageron (1968) and selected censuses from the *Service de Statistique Générale* in *Histoire de l'Algérie Contemporaire*, vol. 2 (1979), p. 97 and *Les Algériens musulmans et la France*, vol. 1 (1968), p. 551.

Table 2.1: European rural population, French Algeria 1872-1948

Year	Eur. Rural Pop.	% of Total
1872	100,549	41
1881	146,647	38
1893	201,541	41
1900	189,164	39
1911	153,441	35
1926	236,672	28
1936	230,311	25
1948	201,009	22

Source: From Ruedy (2005), based on Ageron (1968).

Figure 2.1: Total rural indigenous and settler population,[4] French Algeria 1872-1936



Source: Gouvernement Général de l'Algérie (1948). For further detail on sources see Appendix D.

rural settlers was outpaced by the indigenous population growth after the 1900s (see Figure 2.1).

Several reasons are found to explain this; Colonial historians for instance argued that rural settlement failed due to agricultural inefficiency among local populations while anti-colonialist blamed land speculation. There seems to be a lack of unbiased views and dispassionate analysis (Ageron, 1991; Prochaska, 2004).[3] Yet, in Algerian colonial history one commonly finds the conclusion that land concentration was the main cause of the crowding out of small rural settlement. Interestingly, this hypothesis challenges one of the main purposes of Algeria's colonization: the establishment of a family farm type of settlement.

This chapter examines the institutional component of the settlement process, providing evidence that supports the hypothesis of the crowding-out of rural settlers as a response to

[3]See the first chapter of the book *Making Algeria French, colonialism in Bône*, 1870-1920 by D. Prochaska for a review on the theoretical foundations of historians on colonialism and Algeria.

[4]The settler category is proxied by the non-Muslim group while the indigenous population is proxied by the reported Muslim category.

land concentration. To do so, it analyzes the relation between land concentration, mostly determined by institutional regulations on property size, and European rural population density in the Constantine department at the beginning of the 1900s. It applies an instrumental variable approach using the year of creation of the settlement centers (or *centres de population*) – i.e., territorial entities destined to rural settlers exclusively for agricultural production and delimited by a "colonization perimeter" – to proxy for institutional colonial restrictions of land-size. Algeria's colonial land settlement experience illustrates the interdependence between institutions (i.e., land size restrictions) and geographic features. In other words, when land was available (or the frontier was not exhausted), the institutional force dominated: the creation of a settlement center preceded the settler population, and the size of the land granted for farming was highly controlled. Yet, as the frontier was exhausted and land scarcity became evident, land size restrictions were weakened, demonstrating the unavoidable response of institutions to the relative factor endowments. Thus, I will argue that the land regulations, initially shaped by the colonial goal of achieving a family farm economy and then by land aridity, allow justifying the instrument's exogeneity.

Despite a significant amount of research blaming land concentration, there is no empirical study measuring the relation between land concentration and rural settlement. By analyzing agricultural data collected by the colonial administration in 1904/05 and 1913/14 across one-hundred municipalities (or *communes*), one can see that land concentration was indeed the strongest determinant of the settlement failure. The results will show that a later settlement relates to a higher land concentration. This is consistent with the findings in Chapter 3 demonstrating that a worse land quality in the frontier regions (that is, the ones settled later) required extensive areas for cereal cultivation and more capital and labor investment. The analysis in this chapter also includes additional institutional variables such as the development of road infrastructure and indigenous agency (proxied by the presence of indigenous owners). The results indicate that the road infrastructure (i.e., roads per hectare) hindered land concentration, leading to higher European population density levels. Finally, the results also seem to point towards a positive relation between the presence of indigenous owners per municipality and rural settlers. Thus, this chapter demonstrates how institutions and factor endowments determined the outcome of rural settlement which, according to the colonial administration's ideal, should have been reflected in high rural settler density levels and the creation of a small family farm economy. The reason's as to why the economy went the opposite direction, leading to a progressive higher presence of large landholdings, are analyzed in the following chapter.

2.2 Land Concentration and Rural Failure

There is extensive research on the long-term effects of land ownership distribution on economic growth and development within and across countries. Nonetheless, there is no clear-cut answer as to whether natural geography – for instance, the suitability of land towards cash-crop cultivation – dominates over factor endowments – that is, the relative amounts of land and labor that affect

production methods, choice of crops, or institutions – nor is there an answer as to which are the mechanisms underlying the interaction between these factors (Domar, 1970; Frankema, 2010; Easterly, 2007; Acemoglu et al., 2001). However, beyond the controversy over the transmission channels by which the legacy of settlement affects long-run development, it is undeniable that the evolution of landownership plays an important role (Frankema, 2010; Cinnirella and Hornung, 2016; Erickson and Vollrath, 2004).

In the case of Algeria, it is argued that the increasing levels of settler ownership of large landholdings during the colonial years explain the family-farm settlement failure. Indeed, Algeria fulfilled the requirements – fragmented rural factor market, land scarcity, and labor abundance – for which, according to Griffin et al. (2002), small farmers are a social optimum. They are expected to be more labor intensive and generate a higher output per land unit due to the incentive structure.[5] However, land concentration gives the landowner market power to depart from the social optimum, having a negative effect on rural wages, generating labor surplus, and leading to a decrease in total output. For instance, Martinelli (2014) shows that, in fragmented rural markets, ownership concentration (through market power) drives the relative factor prices, decreasing wages and increasing land rents. Economic theory then predicts inefficiency, higher inequality, and widespread rural poverty among the asset-less workers and tenant farmers. Thus, Constantine is an interesting case-study and, thanks to its available data, allows an analysis of the relation between rural settlement and land concentration. Figure 2.2 provides a first support to the hypothesis of the crowding out of rural settlers; that is, on the one hand, a higher presence of small ownership is related positively with the settler density levels and, on the other hand, a higher presence of large ownership links to lower levels of rural settlers.

2.3 The Process of Land Settlement

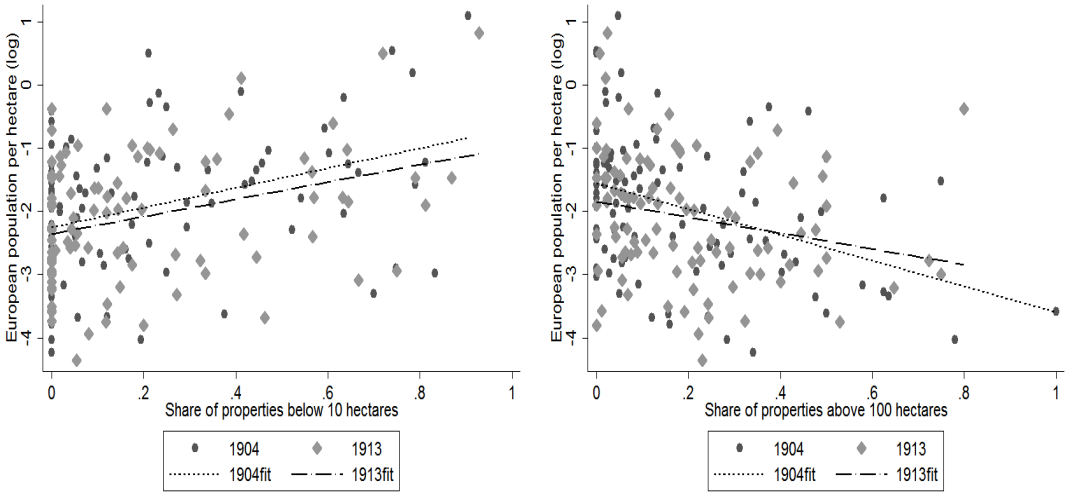
This section demonstrates that, due to the French official colonization policy, before the 1900s the creation of the settlement centers always preceded the arrival of settlers. It outlines how French arrival affected the Algerian land market arguing that the year of creation of the settlement centers reflects a progressive flexibility of the land regime regulations, allowing for higher land concentration. The Europeans in the settlement centers established prior to 1870 were limited regarding the size of their holdings, and government concessions relied on free, small plots of land. As Bennoune (2002, p. 43) explains:

> Up to the 1860s the colonial state had followed an economic policy which aimed at the establishment of homestead farmers on the fertile Algerian lands. For example, between 1841 and 1851, 428,000 hectares were allocated to 15,000 settlers, averaging about 28 hectares each.

[5] For small farmers (in comparison to large landowners) in fragmented rural factor markets, the access to capital is more expensive (particularly because of informal credit markets), land rent is higher (because of the greater opportunity cost due to a lower land endowment), and thus the opportunity cost of labor is relatively lower (Griffin et al., 2002).

Figure 2.2: European rural population and property size distribution, Constantine in 1904/05 and 1913/14

(a) % properties <10 hectares (b) % properties >100 hectares



The lines *04fit* and *13fit* are the trend lines corresponding to the year 1904/05 and 1913/14. Figure (a) displays the relation between the share of properties below 10 hectares and the European population in logarithms. Figure (b) presents the relation between the share of properties above 100 hectares and European population density in logarithms. *Source*: SA (1904/05, 1913/14).

This changed in the 1870s when the new civil administration supplied a larger amount of land, allowing further expansion, but still continued with farm size regulations. These regulations on the size of the granted plots turned less rigid as the administration "realized that large tracts of land were necessary to cultivate the semi-arid areas" (Lützelschwab, 2013, p. 7).[6] After the 1880s it becomes harder to directly link the administration's land policies and rural settlement per se given that the increasing role of the factor endowments (reflected in a growing scarcity of cultivable land as the frontier was exhausted) restricted the administration's margins of maneuver. In 1904 a decree was passed that facilitated the direct purchase of land without the control of the colonial administration by allowing open-land sales to the public. Thus, it is particularly after the 1900s that there was a tendency towards greater land concentration.

Since occupation the French government wanted to ensure the creation of a colony of small farmers that would resemble a "rural democracy of small owners" (Lützelschwab, 2013, p. 7).[7] The ultimate aim was to give the most fertile land to settlers, apply and expand French sovereignty, and justify the cost of colonizing Algeria in the Metropolis. According to the colonial administration, France did not suffer from overpopulation or an economic crisis which might have encouraged voluntary migration (Gouvernement Général de l'Algérie, 1922). For this reason, settlement was organized and managed by the State. This policy, known as official colonization, was based on granting small plots of land located in settlement centers. As explained by Bellahsene (2006), the initial idea of these centers was that of a territorial entity destined solely to rural settlers. That is, the economic activity evolved exclusively around

[6]Chapter 3 provides more detail on the cultivation techniques. The newly open to settlement land in the frontier regions, which was relatively more arid, required extensive cultivation.

[7]The author quotes Rivet (2003, p. 177).

agricultural production and these centers were not intended to become future towns or villages.[8] It was an instrument of conquest and a symbol of colonization so that the creation and territorial expansion of settlement centers was prioritized over the enlargement of the already established ones.

Thus, the case of Algeria is of particular interest as official settlement preceded private settlement. Bellahsene (2006) argues that land settlement was ultimately dependent on the administration's prior evaluation of a center's viability and land availability. Algeria's complexity – which required finding records and interpreting and enforcing new rules in a territory where the land was not empty at arrival,[9] where customary and Islamic law ruled over land tenure, and tribes had inherited Ottoman hierarchical power structures – affected the intensity of expansion but did not paralyze it. As the GGA (1922; p. 13) explains:

> [. . .] the State must necessarily organize the settlement and the economic life of the regions to be opened to European influence and channel and support individual efforts. It must ensure that the colonization of the country be carried out gradually, according to a previously elaborated and systematic plan. In short, official colonization must set the stage for private colonization by supporting individual initiatives.[10]

However, the degree of territorial expansion and land distribution was strongly determined by the type of colonial administration in charge of the settlement process. It changed from a rigorous military administration in the 1870s to a civil settler-friendly, pro-expansion one. Thus, the legal flexibility that limited the size of the granted plots of land was forged by the clash between these two administrations (Sivak, 2008).

On the one hand, the military administration, which ruled from occupation to the fall of Napoleon III's Empire in 1871, was considered to be an obstacle for settlement. According to Sivak (2008, p. 97), "military officers prized stability and clear channels of information-gathering, and the displacements provoked by settler colonialism were not germane to such goals;" moreover, "military administration, with its seemingly limited tolerance for the bourgeois ideals of private property and the free circulation of people and goods, further complicated the picture." This was enhanced by the fact that Napoleon III did not consider Algeria to be a colony, and publicly stated in two letters (1863 and 1865) that he envisioned an "Arab kingdom" that would co-exist with the French (Carroll, 2013).[11] The civil administration, on the other hand, sought to attain a self-sustained and growing European settler population which would adapt to the French administrative organization, differ from the slave-based societies, avoid "the ills of an

[8] As explained in the introduction, according to Bellahsene (2006), the foundational "rural" concept of the settlement centers became more "urban" in 1919 when official colonization had ended and cultivable land was scarce. Its basic structure was a "colonization perimeter" (*Périmètre de Colonisation*) circumscribing a village in the center, designed exclusively to provide accommodation for families, and the to-be-cultivated plots of land were located at a maximum of one-hour distance from the village.

[9] Especially in the fertile areas in the Kabylia (Sivak, 2008).

[10] Author's translation.

[11] "*Lettre au gouverner d'Algérie* – 6 février 1863," in *La Politique Impériale exposée par les discours et proclamation de l'Empereur Napoléon III (Paris: Henri Plon*, 1865).

industrializing metropolitan society" (Sivak, 2008, p. 85), and respond to an ideal of "national renewal" (Sessions, 2005, 2015). Thus, after the 1870s, it became of great importance to secure a land market that would attract settlers and allow expansion beyond the Northern limited civil areas. Property became the instrument through which the land market would be secured so that, as Sivak (2008, p. 68) explains, "organizing the transfer of land and securing a property regime [...] emerged as a key policy objective."

Hence, in the 1830s and the 1840s the colonial administration focused on setting the legal means to appropriate land and establish private property. This was particularly complicated since it involved combining French law and new measures – i.e. "expropriation, verification of traditional land titles, as well as the unilateral adoption of laws that advantaged settlers" (Lützelschwab, 2013, p. 7) – with customary and Islamic law.[12] It is during this time that the institutional framework was built, constituting Algeria's administrative organization and inaugurating the official colonization policy. However, many of the legislative measures undertaken during this period failed since the military campaign was still ongoing, land titles were difficult to determine due to unfamiliar customary and Islamic law, and many Ottoman officials carried away with them important documents after the French occupation (Bellahsene, 2006).

In addition, land speculation was a continuous concern for colonial administration as it increased land prices and discouraged small settlers. This is why throughout the nineteenth century legislation continuously fought against speculative land acquisitions (Bellahsene, 2006).[13] Thus, since occupation, the government undertook a variety of measures – e.g., abrogating unruly land transactions contracted during the occupation years, forbidding sales to Europeans or, to avoid corruption, banning officials or the military from owning any stake in companies) – in order to avoid speculation (Sessions, 2015). This soon led to a systematization of the conditions under which plots of land from public domain were granted to *concessionaires*. For instance, in 1836 the concessions were limited to a maximum of three plots of five hectares each to each settler (the grant was proportional to the settler's resources and conditional on cultivation, improvement, and minimum residence) and in 1838 a decree limited to a maximum of twelve hectares or less the size of land distributed from the State to settlers (Sessions, 2015).

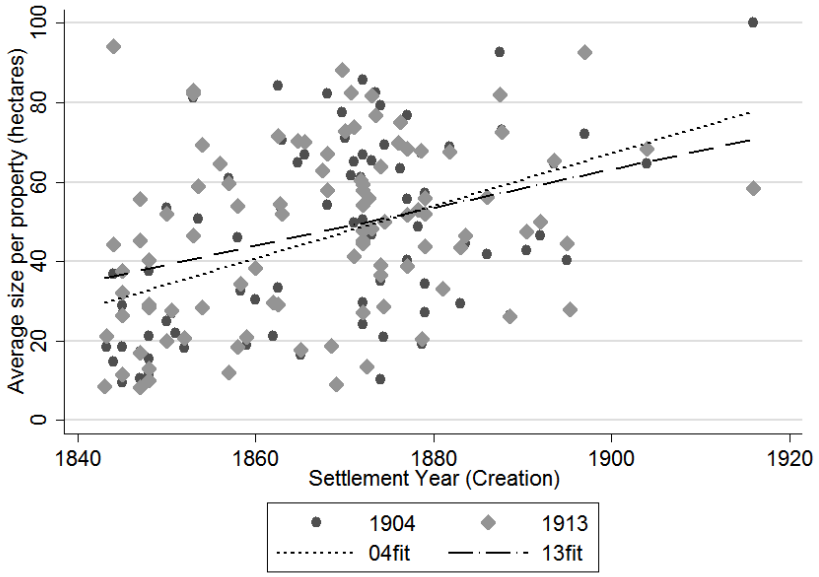
However, although the limit on maximum number of plots was officially suppressed in 1841 the concessions of large areas were frequently hampered by administrative requirements. Indeed, the "granting of smaller concessions was gradually turned over to local authorities in Algeria, but concessions of over twenty-five hectares continued to require the approval from the highest

[12] To expand public domain land the government declared to be the owner by right of empty Ottoman lands (mostly *Beylik*), religious *Habous* lands (an inalienable type of land assigned to an organization related to charity, religious, or civic works) , sequestered lands from French regime opponents and immigrated Turkish tribes, and land declared to be vacant or uncultivated (Lützelschwab, 2013; Sivak, 2008). For more detail see the Introduction.

[13] This is reflected in the following paragraph on the tendency to speculation (author's translation):

> The Administration's role will be to ceaselessly counteract this tendency [land concentration], which has had the effect of slowing colonization down, at best, and altogether compromising it, at worst, through the premature and "unexplained" decay of uninhabited villages, and of lands that were never cultivated but that have instead been leased to their original yet hypothetical indigenous owners. (Bellahsene, 2006, p. 161)

Figure 2.3: European property size and year of creation of settlement centers per municipality, Constantine in 1904/05 and 1913/14



Settlement year (*Creation*) is the average year of creation of settlement centers in a municipality. The *Average size per property* is a weighted average of the size of properties in all groups. The lines *04fit* and*13fit* are the trend lines corresponding to the years 1904/05 and 1913/14. *Source*: SA (1904/05, 1913/14), Busson (1898) and ANOM-iREL. See Appendix D for more detail on sources.

levels of the colonial and metropolitan administration" (Sessions, 2015, p. 248). In line with this, Figure 2.3 demonstrates that in Constantine the European average size of properties was lower in municipalities where the settlement centers had been created earlier. The figure also shows a lower density of dots between 1860 and 1870 caused by the 1863 *sénatus-consulte*, a law that paralyzed settler expansion and land transactions as it prioritized the inventory of indigenous property within tribal areas and the provision of legal land titles in accordance with French law (Bellahsene, 2006, p. 169). This law divided tribal communal lands into municipally self-governing units known as *douars* (see Figure D.3 in Appendix D),[14] "parcelling" lands considered by the administration to be undivided and collectively owned (McDougall, 2017).

The stagnation of new settlements brought in by the *sénatus-consulte* came to an end in the 1870s with the arrival of the Third Republic and the new civil administration. The latter focused on increasing the number of settlements and creating a free land market between settlers and Algerians that would facilitate land access to the former (Lützelschwab, 2013). In particular, the 1873 Warnier law, together with the "little *sénatus-consulte*" law of 1887,[15] encouraged private colonization (Ageron, 1991). These laws facilitated land transactions by extending the French civil code to indigenous land – which had been previously delimited and granted property titles

[14]These territorial units had a council of notables named *djêema* formed by 6 to 16 members (not elected up until 1919) and it was presided by a *Caïd* who was appointed by the French government and proposed by the colonial administrators of its corresponding CM (Sivak, 2008). Although some authors find that the law was originally intended to support Napoleon's idea of an "Arab kingdom" by legally delimiting tribal land (Ageron, 1991), it is also argued that it was directed towards the consolidation of colonial land gains as it provided land titles and thus facilitated legal land transaction (Sivak, 2008).

[15]Which basically fragmented more tribal lands into *douars*.

(due to the *sénatus-consulte*) – and providing more individual property titles to what the colonial administration regarded as collectively owned (Bennoune, 2002). Although these measures increased the State's domain,[16] it especially benefited private colonization by permitting land transactions between Europeans and Algerians. For instance, Bennoune (2002, p. 48) explains that the fragmentation of indigenous landholdings permitted private settlers to acquire, by means of legal auctions, more than 500 thousand hectares of arable land between 1871 and 1896. In line with this, one can see in Figure 2.3 a territorial expansion boom brought in by the civil administration reflected in a higher concentration of dots between the 1870s and the 1880s. Yet this expansion, as explained by Nouschi (1961), was soon limited by the 1897 law (reinforced in 1898) which acknowledged the jurisdictional and economic situation of the *fellah* (indigenous small rural owner) and safeguarded tribal land by consolidating the *droit de chefâ'a*, a right that allowed the indigenous owners to reclaim land titles which, prior to the 1873 Warnier law, had been unduly sold by co-owners of communally-held land.

After the 1900s, the share of ownership in large landholdings increased. A decree was passed in 1904 that changed the land settlement system, turning sales into the general rule and grants into the exception. According to Roberts (1963), this decree reflected a problem which had been developing from the 1880s and that affected rural population; namely that free grants were economically non-viable due to land scarcity. According to the author the direct causality between rural settlement and official colonization disappeared. In other words, success or failure of European settlements was not solely dependent on colonial policies; additional factors, such as land aridity, were playing a role in determining the trend towards land concentration. Still, although land purchases through private colonization gained significance in the twentieth century, it was official colonization which had the stronger role in the nineteenth century (Ruedy, 1967) and, in the words of Belkacemi (1984, p. 152), "without ever disappearing, [private colonization] thrived in the shade of an official colonization generally disdainful towards it."[17]

Ultimately, Figure 2.4 evidences that, in rural Constantine, the relation between settler density and the year of creation of the settlement center is consistent with the process of settlement explained in this section. That is, the transition from a military to a civil administration (which passed laws facilitating transactions and expropriations) determined the expansion boom in the 1870s. The figure also shows the stagnation in the 1860s, due to the *sénatus-consulte*, and, after the 1900s, when official colonization started to reach a "geographic" dead-end (Yacono, 1993). The figure additionally demonstrates that the distribution of the year of settlement aggregated at a municipal level is sufficiently representative of the individually counted one. Thus, one can argue that Constantine's agricultural statistics at a municipal level, conditional on the average timing of settlement, allow to capture the main trends of Algeria's land-policy institutional framework.

[16] Especially by appropriating fallow land declared to be uncultivated or unproductive.
[17] Author's translation.

Figure 2.4: Density of settlement centers and year of creation of settlement centers, Constantine 1904/13 and 1913/14

(a) All settlements individually counted (b) Settlements aggregated by municipality

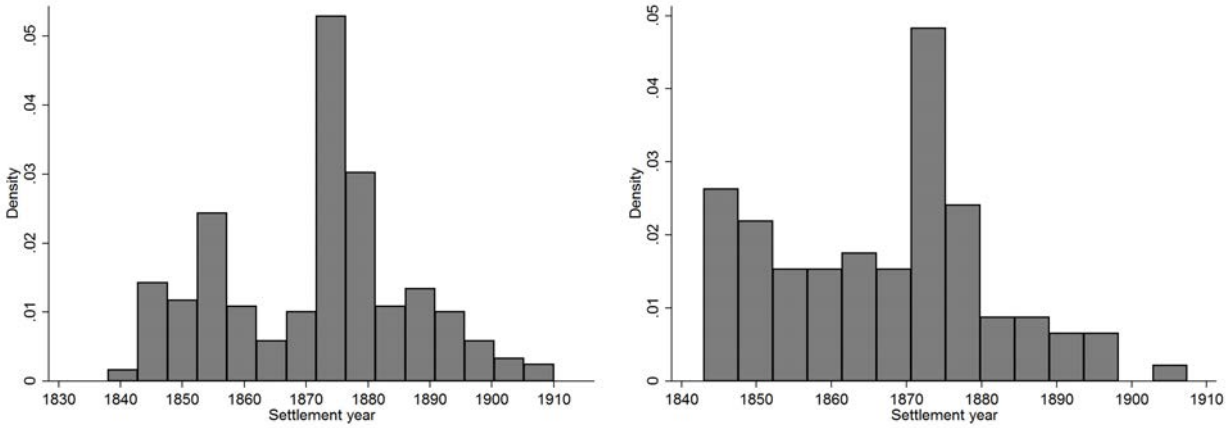


Figure (a): the "All settlements individually counted" sample contains 249 settlement centers for which it was possible to obtain the year of creation. The earliest year of settlement is 1838 and the latest 1910 (mean year is 1871). Figure (b): The "Settlements aggregated by municipality" sample measures the average year of settlement per municipality; that is, the sum of the years of creation of all the settlement centers in a municipality divided by the total number per municipality. The total number of settlement centers is 99, the earliest year is 1843 and the last year is 1904 (the mean is 1867). *Source*: SA (1904/05, 1913/14), *Atlas Administratif de l'Algérie* (2011), Busson (1898), and ANOM-iREL.

2.4 The Indigenous Agency

There is no consensus on the mechanisms explaining the dominance of large rural properties and the resulting crowding out of family settler farms in French Algeria. The prior section has described the main characteristics of the colonial land policy, demonstrating that institutional restrictions on property size permitted larger holdings in the later settled (or frontier) regions. The following chapter will show that these frontier regions, endowed with a highest share of large properties, in order to overcome the scarcity of arable land, required adopting newer agricultural methods that relied (if possible) on labor abundance generated by the colonial land market policies. Hence, the outcome of settler farming ultimately depended on indigenous labor availability. This highlights the importance of understanding the indigenous agency per se – i.e., the "role" or participation of the indigenous populations in production – which, in line with Green (2013) and Frankema et al. (2014), affects the relation between settler farming and labor control.

In sociology or philosophy, and most recently political science, "agency" is commonly understood as the capability of actors to have an effect on a given context. The context sets the conditions on the environments that constrain or facilitate an actor's actions (Lewis, 2002; Sibeon, 1999). A growing literature finds that the role or participation of indigenous populations in production did have an effect on long-term development (Frankema et al., 2014; Green, 2013). According to these studies, prior research neglects the relation between the context generated by both geographic factors, colonial path dependence, and indigenous agency *per se*. In other words, economic history on settlement theory has maintained the idea that indigenous agency is a

deterministic reduction of the environment set by settlers. Yet this analysis can result misleading as indigenous pre-colonial determinants and the participation in the production process during the colonial years played a role as well. For instance, in the case of Algeria, Lützelschwab (2013, p. 2) argues that the indigenous lower production costs outperformed settler small family farming, pushing settlers to engage in "capitalist" means of production. Thus, regardless of whether it hindered or facilitated settler land concentration, indigenous agency should be included in the analysis to fully understand the success or failure of settler farming.

However, although the participation of the indigenous population in the rural economy and the role of pre-colonial institutions require further investigation, their measurement exceeds the reach of this dissertation. Thus, in this section I argue that the indigenous land tenure distribution (for example, a higher share of laborers relative to that of owners) captures the degree of landless labor and thus, of indigenous agency. This is because the owners category during colonialism is regarded as the most prominent and least vulnerable group among all the indigenous rural land tenure classes. Indeed, Nouschi (1961) proves that in Constantine the regional balance between the owners' presence (represented mostly by small ownership known as *fellahs*) versus that of laborers (*ouvriers journaliers*) and sharecroppers (*metayers* or *khammès*) responded to the degree of French occupation. Namely, he argues that in Constantine there was a trade-off relation between the presence of small indigenous owners and the presence of laborers and sharecroppers. This is because the self-employed *fellahs* lost their land and became landless waged labor in the areas most vulnerable to land expropriations, while in areas where resistance to colonization was stronger (predominantly in the Kabylia), indigenous ownership is highest (Nouschi, 1961).

For instance, Lützelschwab (2000) presents an example demonstrating how indigenous labor surplus, explained by a high degree of landless labor, decreased indigenous bargaining power and allowed settlers to increase yields and efficiency (not social welfare) in the *Compagnie genevoise des Colonies suisses* (henceforth, CGCS), a large farming enterprise in Constantine. The author explains that the company, who relied on indigenous sharecropping, in order to increase working time and intensity of labor was forced to modify explicit clauses in the sharecropping contracts to provide incentives.[18] Yet, it resulted particularly difficult to increase the time and effort amidst impoverished sharecroppers (as a result of years of epidemics, drought, and famine) who, in addition, still had the option to search for alternative cultivable land if they disagreed with the new contract terms. However, this situation changed in the 1890s when the labor-to-land ratio increased as a consequence of the massive land expropriations after the Kabylia conflict, generating an excess supply of labor that increased the tenant's bargaining power and allowed the adoption of more labor-intensive dry-farming techniques among the indigenous population. In other words, the land market forces dominated the sharecropping incentive: a lower indigenous agency – reflected in higher levels of landless labor – allowed the large farming estate to engage

[18] Lützelschwab (2000) explains how, after the 1860s, the company had to rely solely on indigenous sharecroppers and abandon direct exploitation by Europeans who failed to cultivate the lands (for different reasons such as epidemics or inappropriate cultivation techniques).

in newer agricultural techniques and increase production.

Table 2.2: Settler and indigenous land tenancy per district, Constantine in 1904/05 and 1913/14

District	Share of agricultural population by tenancy							
	Owners		Tenants		Sharecroppers		Laborers	
	1904	1913	1904	1913	1904	1913	1904	1913
	Settler							
Batna	51	53	11	10	0	1	39	36
Bone	49	53	10	16	5	6	36	25
Bougie	58	69	14	13	3	2	19	22
Constantine	61	57	13	13	6	8	19	22
Guelma	62	60	13	16	2	3	23	22
Philippeville	50	53	19	18	3	4	28	25
Setif	68	73	12	13	4	3	16	10
	Indigenous							
Batna	45	52	2	5	34	23	19	20
Bone	20	21	23	13	21	26	37	39
Bougie	38	49	14	11	28	27	13	27
Constantine	26	33	14	11	34	29	26	26
Guelma	38	37	8	9	42	30	12	24
Philippeville	40	35	3	8	27	27	30	30
Setif	43	45	2	2	39	37	17	16

The share of agricultural population by tenancy is the rural population within one category (owner, tenant, sharecropper, or laborer) over the total rural population. *Source*: SA (1904/05, 1913/14), Archives & Culture (2011), and Busson (1898).

Thus, a lower vulnerability towards land expropriations, reflected in a higher presence of indigenous owners, should partly capture indigenous agency. In addition, the reasoning behind the inclusion of indigenous owners in this analysis also relies on research by Von Sivers (1979, 1982), who provides evidence on pre-colonial institutions demonstrating that not only did an Algerian rural elite persist at least until 1914, but that this indigenous leadership, despite being politically irrelevant, enjoyed economic influence because of its landed and agricultural wealth. This influence was not only present between 1870 and the First World War, but helped determine income and property patterns prior to Independence. The author criticizes the lack of studies on the Algerian social stratum, concluding that Algeria's prominent indigenous category excluded sharecroppers and laborers and that Constantine's local rural elite was mostly reflected by indigenous small rural owners. The following section summarizes Von Siver's (1979, 1982) main findings.

Regarding Algeria's colonial history two misconceptions are commonly found. The first is based on the idea of French direct rule whereas in reality, as Von Sivers (1982, p. 116) clarifies, the French government exercised control by appointing local Algerian administrators to collect taxes. Therefore, despite being "the closest approximation to direct rule feasible in a colony where a foreign minority ruled over an indigenous society," it was far from being direct, and Algerians in rural areas were under Algerian administrators. The absence of French direct control was reinforced in the 1870s due to the arrival of the civil administration, which entailed territorial administrative changes that unintentionally lessened control over local populations.[19] Aware

[19]The new administration appointed civilians (substituting the *Bureaux Arabes*) to the newly created *communes*

of this loss of control in the 1880s, the colonial administration changed the official Algerian appointment system from a body that looked kindly upon the "traditional rural aristocracy" into a "body of commoners" that would facilitate French manipulation on the local indigenous affairs. This change triggered the second misconception: the idea of a successful "decapitation" of the Algerian traditional rural elite which asserts that French government dismantled the traditional family networks within the office positions. Von Sivers (1982) assembles an index based on data from a representative sample of 5,809 administrative tenures between 1846 and 1914,[20] and proves that, to the contrary, the elite survived and maintained its control over local affairs.[21]

The author goes further, examining the prominent indigenous groups shaping leadership in the French political stratum, Algerian land ownership, and income patterns (Von Sivers, 1979, p. 58). He uses French government records from 1898 – compiling information on "names, families, genealogies and material conditions of all people of local and regional notoriety" – to analyze the material situations of Algerian leaders in office. Additionally, he matches the percentage share of income groups among leaders in office in Constantine between 1880 and 1914 to other statistics of wealth and income of leaders in 1860 at the national level.[22] He concludes that the prominent indigenous ownership categories for overall Algeria were the same ones represented in the political stratum and excluded landless sharecroppers and laborers.

With respect to Constantine, as shown in Figure 2.5 (dashed line), more than 50 percent of land ownership in 1914 was of small properties (below 10 hectares). The figure also shows that, regarding indigenous leaders in the administration, the "small" (0-1,500 francs), "middle" (2,000-4,000 francs), and "very large" (10,000-50,000) income groups increased concentration, and that "small" size properties were the ones that increased most between 1895 and 1915. Indeed, Von Sivers (1982, p. 120) explains that in Constantine the "historical-geographic factors clearly played a part in the make-up of the local elite" given that the mountainous regions – mostly endowed with small ownership – helped resist Ottoman rule. Hence, in line with Nouschi (1961), a weakened indigenous population should be reflected by a higher presence of both waged labor and sharecropping. In addition, as argued by Von Sivers (1979, 1982), the indigenous owners, mostly represented by the presence of small-size ownership (*fellahs*),[23] should help capture Constantine's local rural elite.

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mixtes and thus diminished familiarity with local affairs particularly given that colonial issues, such as infrastructure development, were prioritized.

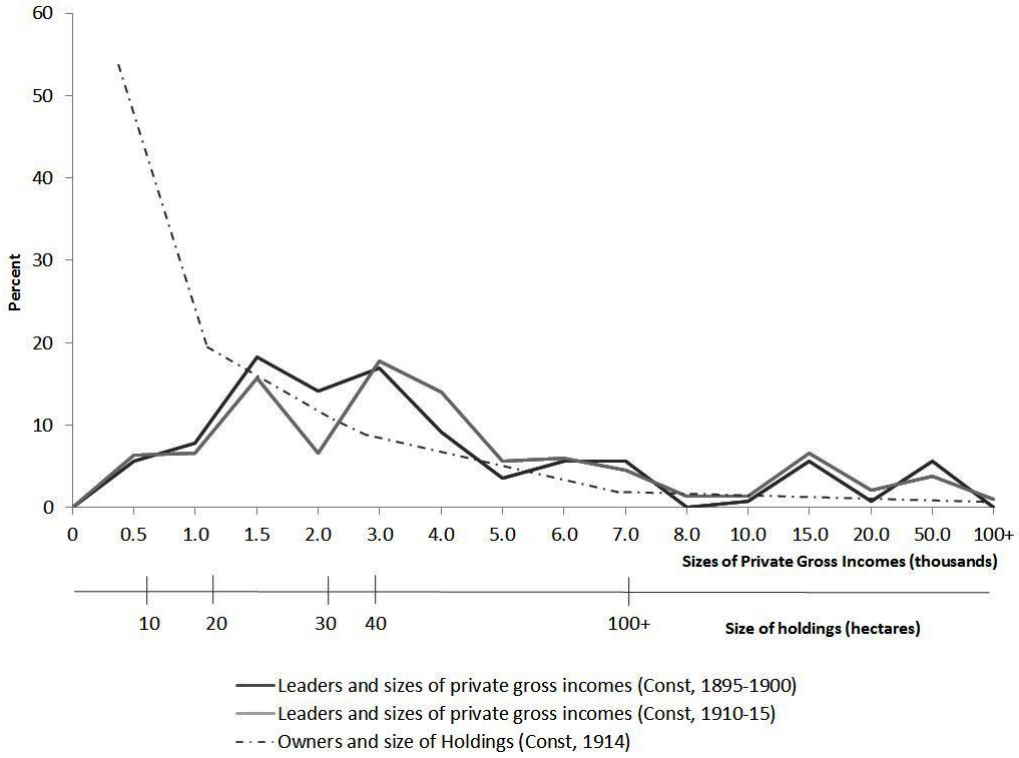
[20] See Von Sivers (1982) for sources. As summarized by him, they come from: "tables of tribal leadership organization, nomination and dismissal forms, personnel files" and a questionnaire undertaken by the French government that registered the wealth of all "notables" in the CPE and CM. Yet these questionnaires span many years and are incomplete.

[21] Von Sivers (1982) finds a significant and constant distribution in the administrative offices of representatives from the most important indigenous families over two generations.

[22] To estimate the material situation of Algerian leaders in office, the author does not include tax commissions and emoluments granted. See Von Sivers (1979, p. 59) for more detail on the estimation procedure. Main sources are obtained from ANOM and Nouschi (1961, p.591).

[23] The correlation between small size indigenous properties and total indigenous owners is almost 50 percent.

Figure 2.5: Share of owners and holdings sizes (1914) and share of leaders and size of Private Gross Income (1895-1915) in Constantine



Source: Sivers (1979); original from Nouschi (1961). For details see Sivers (1979). The 1895-1900 sample contains 142 observations and the one for 1910-1915 includes 286 observations.

2.5 Data and Empirical Model

This section explores whether a higher endowment of large properties affected rural settlement by analyzing the variation across Constantine's municipalities in the early 1900s. It studies the determinants of European rural population – focusing on institutional factors (that is, legal land size restrictions, infrastructures, and indigenous agency) – by applying both ordinary (OLS) and two-stage least square (2SLS) methods. Taking advantage of the first-stage results of the 2SLS, it analyzes the land concentration determinants.

The data used are the agricultural statistics collected by the colonial administration in Constantine in the years 1904/05 and 1913/14. These cover approximately 100 municipalities (or *communes*), allowing to analyze a number of variables that reflect the agricultural economy – e.g., area cultivated, cereal and wine production, capital investment, land tenure categorization, land prices, number of properties, cultivation techniques, etc. – and always differentiate between settler and indigenous population. In particular, this chapter uses the data on the rural population densities, extension of the area cultivated, the land tenure categorization (owners, farmers, sharecroppers, or laborers), and the number of agricultural properties based on size of cultivated area in hectares (below 10, 11-20, 21-30, 31-40, 41-100 and more than 100 hectares). In addition to this data, it uses Geographical Information System (GIS) software to provide spatial reference and control for natural geographic variables (such as elevation and crop suitability for cultivation)

and human geography (such as railways and road density).

The equation to test the effect of land concentration on rural settlement is the following:

$$(EurAgricPop/ha)_{i,t} = a + b_x X'_{i,t} + c_a A'_i + d_d D'_{i,t} + \mu_{i,t} \tag{2.1}$$

There are N sets of observations of municipalities i in two time periods (where $t = 0$ is for 1904/05 and $t = 1$ for 1913/14). The dependent variable is European agricultural population per European-owned hectares in logarithms ($EurAgrPop/ha$). The regressors in vector $X_{i,t}$ that change in time are: i. the European land concentration index ($IndexLC\_E_{i,t}$) and ii. the indigenous agency variable measured as the density of indigenous owners per hectare ($IndigOwnerDen$) or as the share of indigenous owners over the total indigenous agricultural population ($IndigOwnerShare$). In addition to the land concentration index, as a robustness check to the results, I will also use the average European property size ($AverSizeProp(I)$) and the share of large properties ($ShareProp > 41ha$) as proxies to land concentration. The vector A_i accounts for observed municipality heterogeneity factors assumed not to be affected by time change. This is the case for access to the railway infrastructure which was completed by 1900 ($ShortPthRW$),[24] the suitability of land for low rain-fed wheat cultivation in the settlement centers (taking the value of 9 if highest and 1 if lowest) ($CropSuit$), the road network density ($RoadNetwork$), and the ratio of settler-to-indigenous municipal population ($Sett/Ind_{84}$).[25] The vector D' includes several dummies: i. a time dummy ($DYear$) equal to 0 if 1904/05 and 1 if 1913/14, ii. a wine suitability dummy (D_Wine) which is equal to 1 if there are hectares suitable for viticulture and 0 if not, iii. a type of municipality dummy ($DType$) equal to 1 if the municipality is CPE and 0 if CM and, iv. a dummy variable (D_K) reflecting whether the municipality belongs to the Kabylia (equal to 1) or not (equal to 0). In addition, the final models contain dummies capturing the presence of European properties according to the size category in order to provide an additional insight into the European land distribution effects. The equation allows for the constant term a and μ_{it} is the time-varying error. Both the OLS and 2SLS standard errors have been corrected for clustering on the district level.

Research uses different measures to account for land concentration (or land inequality) and its legacy on economic growth and development. The most common one is the GINI index (or Theil index) used by authors such as Vollrath (2013), Martinelli (2014), or Ramcharan (2010). However, this measure is not sensitive towards within group variation. In other words, as explained by Cinnirella and Hornung (2016), if there are only 10 large properties within the same category then the GINI would reflect perfect equality neglecting the relevance of large size ownership. Thus, Cinnirella and Hornung (2016) overcome this by using the share of the largest

[24]The variable measures aggregates the average walking distance from the settlement points to the nearest railway station and the railway-travel distance to the nearest port. Alternative regressions also included individually the average walking distance from the towns to the nearest railway station (in hours and assuming walking speed of five kilometers per hour) but the R^2 decreased and the results did not change significantly.

[25]It includes the population in the settlement centers, *douars*, tribal fractions, and plots of land, proxying for the presence of higher urbanization levels (most settlers were located in towns). It does not allow one to draw any conclusions on the rural land-to-labor ratio.

landholdings,[26] and, alternatively, Erickson and Vollrath (2004, p. 6) use agricultural population per holding since, in their view, the GINI coefficient "misses the important inequalities *across* the land-holders and the landless." This paper, to capture the relative importance of large properties, measures European land concentration as a weighted index of properties according to the share of their size category: the value of 1 is given to properties below 10 hectares, going progressively up to 5 for those above 100 hectares (*IndexLC_E*). It additionally uses other variables to capture large ownership such as the number of properties above 41 hectares (*ShareProp>41ha*) and the average size per property (*AverSizeProp(I)*).[27] The GINI index (*GINI_E*) was also calculated, yet it is not included in the regressions given that there are numerous municipalities that have all properties concentrated in one size category. The correlations in Table A.2 in the Appendix A demonstrate that the agricultural European population has a negative linear relation with all European land concentration variables (*IndexLC*, *AverSizeProp(I)*, *ShareProp>41ha*, and *GINI_E*). This supports the crowding out of the small rural settlers hypothesis; in other words, where there is more land concentration the population density is lower. The highest correlation is -0.34 for the land concentration index ($IndexLC\_E_{i,t}$), -0.33 for *AverPropSize(I)*, -0.20 for *AverPropSize(II)*, -0.30 for *ShareProp>41ha* and, -0.12 for the GINI index.

One may argue that a higher presence of large properties directly implies lower rural-settler density levels or that the areas first settled (hence the most accessible and fertile) clearly were more attractive and thus brought in a higher number of settlers. However, more land concentration does not necessarily imply a lower density. The dependent variable *EurAgrPop/ha* captures the overall land tenure categories as it includes owners, sharecroppers, tenants, and wage-earners. Therefore, an increase in land concentration could lead to lower levels of owners but it could also increase simultaneously the amount of wage earners and tenants (many times due to landless owners turning into waged laborers). Additionally, there are cases such as La Meskiana, Soummam, Aïn Beïda, and Duvivier that report very high levels of both rural settler density and land concentration. Moreover, these four municipalities provide further evidence of no relation whatsoever: between 1904/05 and 1913/14 they experience a strong rural settler population decrease (ranging from 30 percent to up to more than 90 percent of its initial value) but no change (or only slightly) in land concentration (a maximum of 3.4 percent). Ultimately, although the firstly settled and more fertile areas resulted more attractive to settlers, the official colonization

[26] To proxy for the reliance upon serfdom and laborers in Prussia's agrarian economy.

[27] See Appendix for variable construction and descriptive statistics on the different land size variables. The main problem with the average size per property is that it does not reflect the distribution within municipalities. Given the agricultural statistics available for Constantine, there are two methods for calculating the latter. The one included as an explanatory variable (*AverSizeProp(I)*) requires assigning the mean size value within each size category (for example, to the category between 0 and 10 hectares, I assign the value of 2.5 hectares) and multiply each of them by its corresponding share over the total number of properties. The problem with this approach is that it does not distinguish size beyond 100 hectares and thus requires assuming the mean value for the largest properties. The other option is to directly calculate the ratio between the number of hectares owned by Europeans over the total number of European-owned properties (*AverSizeProp(II)*). However, the problem with this method is that the variable construction comes from two different sources and thus one cannot recognize whether the European-owned (cultivated and non-cultivated) hectares in the numerator refer to the same properties as the ones in the denominator.

controlled settlement, prioritized territorial expansion over urbanization, and assigned the plots of land according to the number of settlers (family and members). Thus, an earlier established settlement center does not necessarily imply higher rural settler densities.[28]

Regression estimates by OLS are inconsistent if there is reverse causality. In other words, one could argue that explaining rural settlement using land concentration runs into an endogeneity problem given that land amalgamation affects rural settlement but rural settler density might also influence land distribution. As a result, despite passing the exogeneity test for all variables (shown later), and having argued in section 2.3 that land ownership size was limited and determined prior to settlement, the analysis includes an instrumental variable approach as a robustness check to the exogeneity problem.

A 2SLS is used to instrument European land concentration (*IndexLC_E*) with the average year of creation of the settlement center per municipality (*Creation*). The year of creation of a settlement center, which accounts for the land size restrictions set by the colonial administration, should capture the exogenous variation on land concentration due to institutional restrictions. These restrictions, initially very rigid with regards to the size of the granted plots of land, became more flexible and permitted a greater presence of large properties, partly as a response to Algeria's land aridity on the frontier (namely the regions settled after the 1870s). Indeed, as Figure 2.6 demonstrates, the relation between crop suitability and year of settlement for the older municipalities (i.e., settled before 1870) is different to the one given on the frontier municipalities (i.e., settled after 1870),[29] evidence that the later the settlement center was inaugurated, the worse the land quality for cultivation.

Regarding the instrument's validity, the variable *Creation* is not a weak instrument: the correlation with land concentration is almost 50 percent and positive, it has a reasonable explanatory power in the first stage regression (significance at a 1 percent level), and the F-statistic for joint significance is above ten. However, it could still be argued that even though a settlement was established before the 1870s (under more strict land policies), the latter could experience territorial expansions after the 1870s (with less strict farm size restrictions) and thus, the initial year of settlement is not accurately capturing institutional land size restrictions. Yet, the information provided by Gouvernement Général de l'Algérie (1922) shows that none of the earlier settled municipalities experienced territorial enlargements nor the arrival of more settlers (indeed, the colonial administration prioritized geographic expansion by means of creating new settlement centers rather than increasing the size of the ones already established). Among the 183 settlement

[28] Clearly the proportional relation between the number of settlers and the number of assigned plots weakens for the settlements established later in time because private colonization gained relevance. However, assuming that the relation is proportional, a t-test on the mean differences between the number of settlers in the relatively better quality pre-1870 settlement centers and the post-1870 ones is not significant. See Table A.3 in the Appendix A for detail on the number of initial settlers established in the settlement centers.

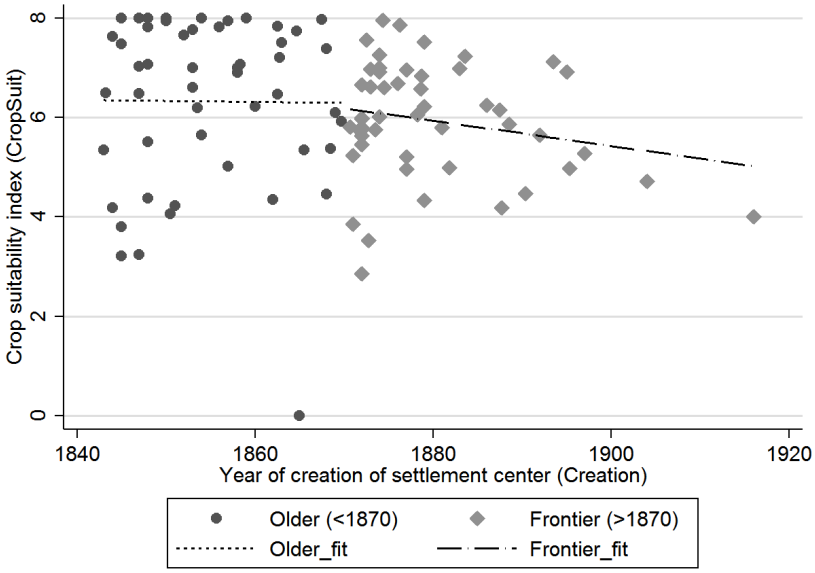
[29] The correlation coefficient is -0.01 for the Older municipalities and -0.27 (and significant at a 5 percent confidence level) for the frontier. The outlier in the older municipalities that has a zero crop suitability level is Biskra, a strategical region on the way to the Sahara. If I drop it from the sample, then the correlation is 0.1 and insignificant.

Table 2.3: Determinants of European agricultural population, Constantine in 1904/05 and 1913/14

Dependent variable: European agricultural population per hectare ($EurAgrPop/ha_{i,t}$)															
	OLS (1a)	2SLS (1b)	OLS (2a)	2SLS (2b)	OLS (3a)	2SLS (3a)	OLS (4a)	2SLS (4b)	OLS (5a)	2SLS (5b)	OLS (1c)	OLS (2d)	OLS (3e)	OLS (4f)	OLS (5g)
IndexLC_E	-0.380***	-0.562**	-0.376***	-0.551**	-0.376***	-0.553**	-0.358***	-0.513*	-0.363***	-0.524*					
	(0.053)	(0.247)	(0.053)	(0.269)	(0.054)	(0.274)	(0.028)	(0.277)	(0.049)	(0.286)					
ShortPthRW	-0.037	-0.024	-0.036	-0.024	-0.035	-0.024	-0.029	-0.020	-0.032	-0.023	-0.026	-0.022	-0.022	-0.018	-0.023
	(0.036)	(0.028)	(0.037)	(0.027)	(0.036)	(0.026)	(0.029)	(0.018)	(0.035)	(0.025)	(0.030)	(0.031)	(0.031)	(0.031)	(0.045)
CropSuit	0.104	0.133	0.094	0.126	0.094	0.126	0.145	0.170*	0.087	0.117	0.088	0.071	0.071	0.042	0.064
	(0.082)	(0.095)	(0.080)	(0.102)	(0.080)	(0.103)	(0.076)	(0.099)	(0.080)	(0.104)	(0.098)	(0.094)	(0.094)	(0.096)	(0.072)
RoadNetwork	0.167*	0.147**	0.169*	0.149**	0.170**	0.150**	0.135*	0.120*	0.175*	0.157**	0.222***	0.225***	0.225***	0.193***	0.225**
	(0.072)	(0.072)	(0.070)	(0.073)	(0.069)	(0.072)	(0.055)	(0.067)	(0.074)	(0.080)	(0.071)	(0.070)	(0.070)	(0.070)	(0.080)
DWine	-0.635	-0.665*	-0.632	-0.662*	-0.633	-0.663*	-0.742	-0.762**	-0.584	-0.618	-0.514	-0.523	-0.525	-0.500	-0.491
	(0.452)	(0.396)	(0.455)	(0.402)	(0.455)	(0.401)	(0.440)	(0.387)	(0.453)	(0.407)	(0.324)	(0.329)	(0.334)	(0.324)	(0.543)
DYear	-0.019	0.003	-0.019	0.002	-0.019	0.002	-0.033	-0.013	-0.044	-0.022	0.029	0.027	0.027	-0.010	0.000
	(0.079)	(0.093)	(0.079)	(0.093)	(0.079)	(0.094)	(0.072)	(0.089)	(0.080)	(0.095)	(0.098)	(0.098)	(0.098)	(0.097)	(0.021)
DType	-0.437	-0.551**	-0.412	-0.533*	-0.417	-0.541*	-0.364	-0.475*	-0.271	-0.402	-0.347	-0.300	-0.302	-0.113	-0.206
	(0.231)	(0.261)	(0.224)	(0.276)	(0.235)	(0.294)	(0.205)	(0.260)	(0.281)	(0.313)	(0.235)	(0.235)	(0.239)	(0.239)	(0.262)
Sett/Ind_84			-0.380	-0.191	-0.396	-0.213	0.023	0.191	-0.353	-0.194		-0.773	-0.782	-0.392	-0.736
			(0.621)	(0.570)	(0.656)	(0.564)	(0.486)	(0.450)	(0.515)	(0.500)		(0.768)	(0.768)	(0.785)	(0.536)
D_K					-0.030	-0.043	-0.046	-0.050	-0.081	-0.087			-0.014	-0.047	-0.046
					(0.163)	(0.150)	(0.162)	(0.145)	(0.156)	(0.136)			(0.187)	(0.185)	(0.182)
Owners/ha_I							0.517**	0.484***						0.194***	
							(0.145)	(0.167)						(0.074)	
ShareOwners_I									0.530**	0.462**					0.361**
									(0.215)	(0.223)					(0.145)
D_11 <ha <20											-0.316*	-0.338*	-0.337*	-0.242	-0.293
											(0.182)	(0.181)	(0.182)	(0.191)	(0.195)
D_21 <ha <30											0.240	0.221	0.219	0.241	0.230
											(0.204)	(0.204)	(0.208)	(0.200)	(0.165)
D_31 <ha <40											0.176	0.211	0.214	0.188	0.201
											(0.291)	(0.294)	(0.298)	(0.281)	(0.229)
D_41 <ha <100											-0.280	-0.325	-0.325	-0.168	-0.305
											(0.280)	(0.286)	(0.286)	(0.293)	(0.158)
D_>100ha											-0.639***	-0.589***	-0.590***	-0.503**	-0.533
											(0.212)	(0.220)	(0.221)	(0.202)	(0.341)
Constant	-1.552**	-0.966	-1.200	-0.818	-1.177	-0.781	-1.975**	-1.610	-1.551*	-1.147	-2.486***	-1.744**	-1.731**	-1.868**	-2.026***
	(0.537)	(1.093)	(0.725)	(0.914)	(0.831)	(1.034)	(0.589)	(1.020)	(0.672)	(1.001)	(0.612)	(0.755)	(0.769)	(0.805)	(0.403)
N	193	193	193	193	193	193	191	191	193	193	195	195	195	191	195
R^2	0.28	0.24	0.28	0.25	0.28	0.25	0.32	0.30	0.30	0.27	0.21	0.22	0.22	0.26	0.23
R2_A	0.25	0.21	0.25	0.21	0.24	0.21	0.29	0.26	0.26	0.23	0.17	0.17	0.16	0.20	0.17

*Significant at 10%; **significant at 5%; *** significant at 1%. Cluster-robust standard errors in parentheses. In 2SLS $IndexLC\_E$ is instrumented with *Creation*. Dependent variable is in logarithms. *Source*: SA (1904/05, 1913/14), Busson (1898), ANOM-iREL, and GIS databases. See Appendix D for more detail on sources.

Figure 2.6: Year of creation of a settlement center and crop suitability per municipality, Constantine in 1904/05 and 1913/14



The *Older* municipalities have an average year of creation of settlement centers below 1870, while the *Frontier* municipalities report an average above 1870. The lines *Older_fit* and *Frontier_fit* are the trend lines. The *Creation* is the average year of creation of a settlement center per municipality. *CropSuit* is the crop suitability index (class) for low input level rain-fed wheat (the highest value is 9 and the lowest value is 1). *Source*: SA (1904/05, 1913/14), Busson (1898), ANOM-iREL, and IIASA/FAO Global Agro-Ecological Zones Database. See Appendix D for more detail on sources.

centers reported to be created or enlarged between French occupation and 1900, only 10 were expanded (8 were enlarged in the 1890s, 1 in 1881, and 1 in 1878), so that the vast majority of enlargements were undertaken after the 1900s.

Opting for the 2SLS approach has two advantages; firstly, the first-stage estimates allow one to examine the hypothetical channels through which land concentration affected population and, secondly, it reinforces the OLS results. By isolating the explanatory power of the instrument on land concentration in Table 2.4 (first-stage results), it is possible to infer which hypothesis holds better regarding the channels that led to a higher presence of large estates: the restrictions on land size (colonial institutions), the land's suitability for wheat cultivation (natural geography), the road and railroads (infrastructure development), the prior settler-to-indigenous ratio (urbanization), and an indigenous agency proxy (which also should partly capture pre-colonial institutions). These results provide insights into the general debate on the channels through which colonialism might affect long-term growth.

Table 2.3 shows the OLS and the 2SLS estimations. Regressions 1a and 1b do not take into account the indigenous agency variables; 2a and 2b include the ratio between the number of settlers and the indigenous population in 1884; and the regressions 3 to 5 include the indigenous agency variables. The remaining five columns (1c, 2d, 3e, 4f, 5g) examine land concentration according to property size by including a dummy reflecting the presence of properties by size (*D_<10ha* is the reference, while the other dummies are equal to 1 if there are properties between 11 to 20 hectares, 21 to 30, 31 to 40, 41 to 100 and above 100 hectares). Standard errors are cluster-robust, and Wooldridge's (1995) robust regression-based test on endogeneity shows that

we cannot reject exogeneity of all variables.[30] These results are consistent with the ones obtained using alternative land concentration variables (see Tables A.7, A.4, A.5, and A.6 in Appendix A).

It is clear from Table 2.3 that land amalgamation had a significant and negative effect on population density across municipalities. Results estimated by OLS and 2SLS are consistent with the hypothesis of the crowding out of rural settlement. The first-stage regressions estimates (Table 2.4) show that the year of creation of a settlement has a strong predicting power (at a 1 percent significance level) on the average size of property; that is, an earlier settlement related to more strict institutional farm-size restrictions, while the settlements after the 1870s experienced lower regulations as a response to land aridity. The negative effect of both land concentration and the instrument on the settler density is logical given that – as Chapter 3 will explain in more detail – the higher aridity in the frontier regions required dry-farming techniques. These techniques relied on extensive plots for cultivation and necessitated more intensive labor and instruments. Thus, working the frontier lands resulted more expensive and the progressive fall of restrictions to private land transactions (and fading of official colonization) help explain the lower rural settler levels. Estimates by OLS show that, on average, a 1 unit decrease in the land concentration index (*IndexLC_E*) leads to a 38 percent increase in the rural settler density. This implies that it can range from an increase of less than 1 settler in a remote area such as Akbou (an increase from 0.006 to 0.01 settlers per hectare), to an increase of more than 200 settlers (0.07 settler per hectare) in a better communicated area like Sétif. The instrumental variable estimates increase the coefficient up to more than 50 percent on average. However, due to the reliability of historic agricultural statistics and the limited number of observations for Constantine, it is recommended to take only into consideration the negative sign rather than the size of the coefficient.

The road network has a direct and significant effect in both the first and second stage tables, implying that it hindered land concentration (Table 2.4) and helped rural settlers (Table 2.3). Indeed, as Belkacemi (1984) explains, roads had been initially built in the 1830s to guarantee military control during occupation and, up to the 1870s, they consolidated colonial settlement by expanding security and trade, enhancing land values, increasing agricultural production, and lowering prices. They shaped the evolution of colonial villages, departing from initial *postes-cafés* or *caravenserais*, whose unique function was to cater for travelers or operate as control points (Belkacemi, 1984). Roads not only determined the location of most settlements but they probably made family farms more competitive (making concentration harder) by reshaping economic geographies and local networks.[31] Additionally, it is plausible that its initial attraction for speculation provoked the colonial administration to implement land size regulations within its surroundings, hindering land concentration. Regarding reverse causality, the road infrastructure

[30] It is the only exogeneity regression-based test that allows clustering. The endogeneity test (adjusted for 7 clusters corresponding to districts) reports for model 1b a p-value of 0.43, for model 2b a p-value equal to 0.50, for 3b has a p-value of 0.58, for 4b of 0.47, and for 5b a p-value of 0.57.

[31] This is a growing line of research that merits further investigation. See Jedwab et al. (2015); Jedwab and Moradi (2016).

developed slowly and, by the time the civil administration arrived in the 1870s – changing the roads' role from strategic to economic – the settlers demanded railways instead of roads (Belkacemi, 1984), thus suggesting that road expansion preceded rural settlement.[32]

The railway variable does not show a significant effect. This in accordance with Chapter 4 that analyzes in more detail the effects of the railway infrastructure on population densities. Indeed, small rural cultivators barely benefited from the railway infrastructure in Constantine. As explained by Nouschi (1961) and Belkacemi (1984), the tariffs were high and their structure gave comparative advantage to large producers, particularly as these were lower for large volumes of merchandise. In addition, given that all goods were charged equally, it was relatively more expensive for small cultivators to transport cheap products such as wheat or barley. In fact, it was less expensive to import cereal from France than to transport it between Algerian regions, and the frequent delays often ruined the product.

The model also includes the indigenous agency variable which, as argued in Section 2.4, accounts for the share of indigenous population least vulnerable to colonial land policies and most represented in office. Although these variables have potential reverse causality problems and thus the coefficients must not be interpreted as causal relations, it is interesting to see how it relates to rural settlement. The regressions 3a to 5b in Table 2.3 show that the two variables ($IndigOwnerDens$ and $IndigOwnerShare$) are positively and significantly related to European agricultural population density. The question is why the relation is positive. As previously shown, and in line with the crowding-out hypothesis, the regions endowed with higher levels of large landholdings link to lower levels of European rural settlers. The large settler estates in these regions – particularly the ones engaged in dry-farming and viticulture – benefited from a surplus of landless indigenous labor (represented by laborers and sharecroppers) and thus, it is reasonable that indigenous ownership is lower in the regions endowed with large and labor dependent settler estates.[33] Yet these results point towards a potential relation between settler farming and indigenous agency but do not allow for any causal interpretation; thus, the following step (which exceeds the reach of this thesis) would be to undertake a simultaneous variable approach to estimate the bi-directional causality between them.

The geographical factors such as wheat or wine suitability do not show a direct effect on population density or land concentration. With respect to crop suitability, since areas suitable for viticulture are also appropriate for wheat cultivation, it is not possible to identify and quantify the individual effect of each crop on population density. Crop suitability for low input level rain-fed wheat does not show a significant relation but it is consistently positive throughout all models in Table 2.3, implying that a higher suitability relates to more rural settlers per hectare. Yet in the

[32] In addition, to strengthen the argument against reverse causality, the roads that could have been built as a response to the settlers' demands were only built after the 1900s because it is then that it became financially possible: the colony achieved financial autonomy and thus allowed to devote funds to building new roads as opposed to devoting the limited budget solely to railway expansion.

[33] The abundant indigenous labor supply was generated after the 1870s as a result of colonial land expropriations and persistent indigenous demographic growth (for more detail see Chapter 3).

Table 2.4: Determinants of European agricultural land concentration, Constantine in 1904/05 and 1913/14

Dep. variable: European land concentration (IndexLC_E)					
	2SLS (1b)	2SLS (2b)	2SLS (3b)	2SLS (4b)	2SLS (5b)
Creation	0.034***	0.033***	0.033***	0.033***	0.032***
	(0.007)	(0.007)	(0.008)	(0.007)	(0.006)
RoadNetwork	-0.078**	-0.081**	-0.080**	-0.071*	-0.082**
	(0.030)	(0.028)	(0.027)	(0.035)	(0.029)
ShortPthRW	0.056	0.054	0.055	0.055	0.053
	(0.034)	(0.038)	(0.039)	(0.044)	(0.040)
CropSuit	0.157	0.167	0.167	0.140	0.170
	(0.092)	(0.110)	(0.110)	(0.100)	(0.107)
DWine	-0.153	-0.156	-0.157	-0.131	-0.184
	(0.222)	(0.234)	(0.233)	(0.236)	(0.229)
DYear	0.114	0.113	0.113	0.108	0.127
	(0.079)	(0.080)	(0.081)	(0.079)	(0.088)
DType	0.055	0.018	0.011	-0.042	-0.081
	(0.451)	(0.455)	(0.480)	(0.515)	(0.528)
Sett/Ind_84		0.389	0.369	0.197	0.352
		(1.121)	(1.132)	(1.274)	(1.097)
D_K			-0.040	-0.010	-0.011
			(0.182)	(0.171)	(0.181)
Owners/ha_I				-0.109	
				(0.080)	
ShareOwners_I					-0.301
					(0.357)
Constant	-60.415***	-59.417***	-59.275***	-58.396***	-57.883***
	(13.600)	(13.823)	(14.373)	(13.998)	(11.990)
N	194	194	194	189	193
R^2	0.28	0.28	0.28	0.28	0.29
R2_A	0.26	0.25	0.25	0.24	0.25

*Significant at 10%; **significant at 5%; *** significant at 1%. Cluster-robust standard errors in parentheses. *Source*: SA (1904/05, 1913/14), Busson (1898), ANOM-iREL, and GIS databases. See Appendix D for more detail on sources.

two stage step (Table 2.4) it appears (although insignificant) with a positive sign, supporting that wheat suitability positively related to land concentration; indeed, wheat cultivation was pushed south into the frontier (giving place to viticulture in the north) and was characterized by extensive fields, thus linking to land concentration. In Table 2.3 the dummy variable for wine suitable municipalities has a negative and persistent relation (and sometimes significant) implying that the areas suitable to wine on average were associated with inferior levels of rural settlers. In fact, as explained in Chapter 3, viticulture in Algeria was characterized by capital intensive large estates that, in contrast to the small family wineries found in the southern regions in France,[34] required a significant capita investment and thus access to its production was limited.

The institutional dummy accounting for the type of municipality ($DType$) is occasionally

[34]Further research should look into this relation since, as explained by Isnard (1959), one theory on Algerian wine argues that settler population and wine expansion were dependent on each other, implying a cause-effect relation that finds the *Statut Viticole* in the 1930s (which imposed size limit on wine plantations) to be the cause of the population settlement stagnation. This is criticized by authors who argue that although viticulture expansion reinforced rural settlement, it did not cause it (proven by the fact that official colonization located settlers in the settlement centers with no viticulture).

significant in both the ISLS and 2SLS models. This variable, equal to 1 if CPE and 0 if CM, accounts for the territory under French law versus the areas under Islamic and customary/traditional law. The negative and occasionally significant effect on rural settlement (as displayed in Table 2.3) is reasonable given that, as Bellahsene (2006) explains, the possibility to implement French law and establish private property titles in the CPE, as opposed to tribal land areas which entailed a higher complexity in the CM, facilitated appropriation and expansion. This result provides an insight into the channels through which differences in "legal origin" – in this case, common law versus Islamic law – can affect long-term development (La Porta et al., 2008). Finally, additional variables such as the ratio between the settler municipal population and the indigenous one in the 1880s (*Sett/Ind_84*), the year dummy, and the Kabylia dummy are not significant.

2.6 Conclusions

By studying the case of Constantine at the beginning of the twentieth century, this study provides empirical evidence that supports the hypothesis of the crowding-out of rural settlers as a response to land concentration in French colonial Algeria. Results estimated by OLS and 2SLS demonstrate that land amalgamation had a significant and negative effect on population density across municipalities. By taking advantage of the first-stage results, this paper examines the channels through which land concentration affected settlement failure, providing support towards the interdependency between the institutional forces (i.e., the land regulations aiming for a small family-farm type of settler ideal) and the relative cultivable land availability.

In other words, it seems that the official colonization policy implemented by France, which in the nineteenth century limited land concentration expansion by means of granting small plots of land, did have the ultimate effect on land concentration. Yet as soon as land scarcity became evident at the turn of the century because of Algeria's land aridity, land-market institutions had a weaker direct influence on settlement and allowed land concentration. The regions settled on the frontier, which are endowed on average with larger properties, required more capital investment to expand cultivation (this is examined in more in detail in Chapter 2) and thus help explain the crowding out of small, family farms. Results show that the presence of the road network played an important role as well, having a positive effect on the small rural settlers and hindering land concentration. Finally, although it is not possible to make any causality conclusions, the inclusion of indigenous owners as a control variable for the presence of "indigenous agency" shows that the latter positively related to family farm settlers. Overall, the results suggest that the institutional variables – channeled through land policies and infrastructures – had the strongest effect on the outcome of rural settlement and land concentration.

Chapter 3

Factor Endowments and Farm Structure: A Regional Approach

Abstract

The adaptation of crops, agricultural techniques, and farm size to the new environments ushered in by colonialism help identify the sources of long-term growth and development. This chapter is a simplified approach to this adaptation process. It examines the relation between factor endowments (land and labor) and the process of settlement itself in the Constantine region at the beginning of the 1900s. French Algeria boosted grain and wine production during the colonial years, but differently to that of the new overseas grain exporters, the Algerian farming system diverged into large estates reliant on indigenous wage labor and sharecropping. As fertile land became increasingly scarce, the ability to participate in the grain export market depended on the capability of engaging in modern agricultural techniques. The results demonstrate that the adoption of new agricultural methods on the frontier and later settled regions depended on the abundance of indigenous labor but required larger capital investment to offset the worse land quality, ultimately explaining the lower rural settler density levels. Thus, abundance of indigenous labor was the key factor that permitted engaging in the cereal export-led sector in a land scarce settler economy. This provides further evidence on the mechanism underlying regional differences in farm structures, helping to identify the impact of colonialism on agrarian structures.

3.1 Introduction

The international trade environment evolved rapidly at the turn of the twentieth century. It was a period of world market integration, leading to changing relationships between nations, through shifting specializations and comparative advantages (Findlay and O'Rourke, 2008). This phase of world integration was considered to be "the 'golden age' of settler societies;" which comprehended "the long 19th century (1814-1914) and, particularly, the First Globalization era (1870-1914)" (Willebald and Bértola, 2013, p. 106). In French Algeria commercial agriculture boomed and trade became one of the key drivers of development, conducing to a structural transformation in the rural economy. The settlement process implied a regional integration into the international economy and, as settlers moved into the interior regions, the relation between geographic features (such as land quality) and population densities changed.

Although there are a substantial number of studies that examine the effects of land inequality (or concentration) on long-term development, the origins are unclear (Vollrath, 2013; Engerman and Sokoloff, 2002; Easterly, 2007; Frankema, 2010; Erickson and Vollrath, 2004; Cinnirella and Hornung, 2016).[1] In Algeria, the newly established factors of production – mainly reflected in the land-to-labor ratio – shaped the regional differences in agricultural production and farm structure. The development of commercial agriculture – characterized by cash crop production and relatively large landholdings – led to high levels of land inequality even prior to Independence in 1962 (Griffin, 1976; Ageron, 1991). This chapter analyzes the way in which the relative factors of production shaped regional differences in farm structures, helping to identify the origins of settler land concentration.

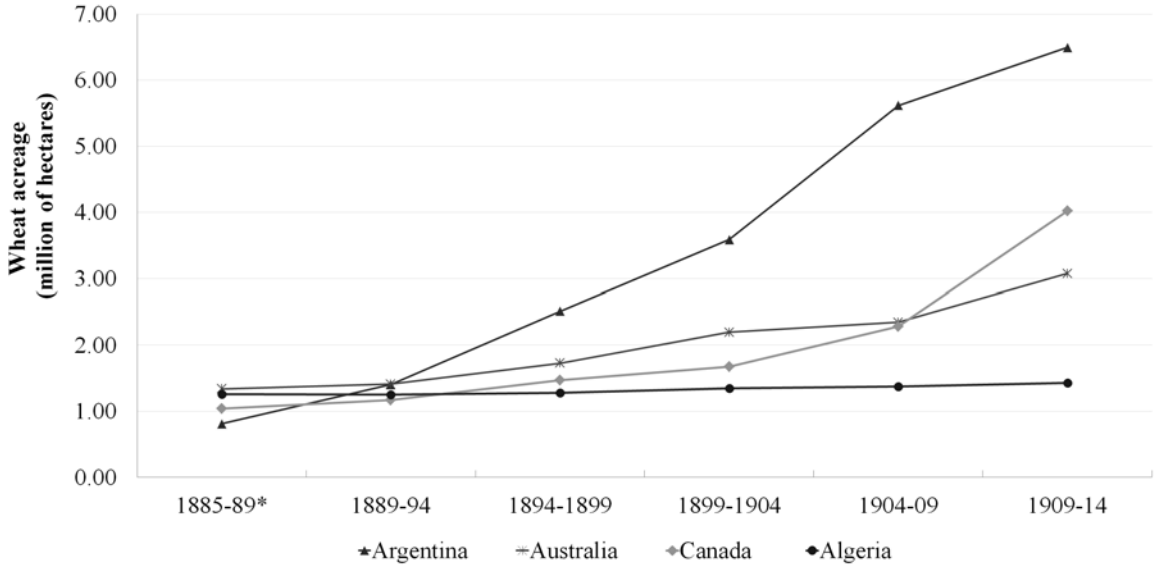
Despite the initial "fertility myth" of Algeria, which had inflated settler's expectations,[2] the colony was not abundant as far as land was concerned. The lack of arable land became particularly evident after the 1870s as one moved towards the frontier. This located the country far from a new form of family farming characterized as land-abundant and self-sufficient as the one described by Offer (1991) that appeared at the end of the nineteenth century among the overseas grain growing countries. Indeed, as shown in Figure 3.1, although in the mid-1850s Algeria ranked above Argentina and showed similar levels to Canada or Australia in terms of total acreage devoted to wheat, by the years prior to 1914 the figures had changed. While the other countries had at least doubled their extension, French Algeria stagnated, increasing modestly at only 13.5 percent over its initial value.

Nonetheless, regardless of the limitations on arable land, settler-owned large properties

[1] As reviewed by Frankema (2010), the debate is inconclusive as some argue that local endowments – geographical features, natural resources, or factors of production — shaped land distribution, while others highlight the role of institutional variables (Easterly, 2007; Engerman and Sokoloff, 2002; Acemoglu et al., 2001). In addition, according to Frankema (2010), local endowments can explain a higher presence of large estates but are insufficient to account for the distribution patterns, unless complemented by political economy arguments (for example, the creation of coercive institutions to obtain labor).

[2] Based on the "'myth' of Algeria's great fertility" rooted in the Greek and Roman ideal of North Africa. See Sessions (2015, Chapter V) for more detail.

Figure 3.1: Total wheat acreage, 1885-1914 (5-year moving average) from Malenbaum (1954)



* Is a 4-year moving average. *Source*: Malenbaum (1954).

represented an important proportion. Section 3.2 will demonstrate that the portion of cultivated land owned only by Europeans was relatively high and positioned the colony between the United States and Great Britain. Yet, Algeria's indigenous labor availability – mostly originated from colonial land policies after the 1870s – helped consolidate a farm structure more in line with Great Britain; that is, an unequal three-class system composed of landowners, tenant farmers, and farm laborers (Offer, 1991). This is interesting given that since its arrival, the colonial administration strove to create a rural and equal society of small family farms (see Chapter 2 for more detail). However, despite the institutional efforts to limit the size of landownership, the country turned out to be a speculative cash crop producing colony made up of relatively large estates devoted mainly to wheat and wine (Ageron, 1991).

These large properties, most commonly described as large, capitalist, export-led, labor-dependent estates, are regarded by numerous historians that study French Algeria as one of the main determinants of the failure of rural settlement and as the origins of a highly unequal and fragmented economy. Sometimes they are described as large landholdings owned by companies or individuals and dependent on rents and indigenous sharecroppers, while other times they are defined as modern, large, and wage-dependent. Recognizing the differences of the various farming models, such as whether they are based on labor-dependent or self-sufficient families, is important as they do not respond in the same way to changes in relative factor prices, nor do they make the same decisions based on a given a set of factors of production.

Thus, one of the central issues addressed in this chapter is the study of how these large estates responded to factor endowments. So far I have proven that large rural properties were mainly located in the later-settled municipalities or frontier regions.[3] These were able to boost cereal

[3]See Section 3.3 in the Introduction and Chapter 2.

production as long as they innovated and adopted newer and more intensive agricultural techniques to overcome the relative worse land quality.[4] However, the adoption of these techniques depended on the land-to-labor ratio.[5] The dependence on the labor-to-land ratio also holds true with respect to the regional diffusion of mechanization. A relatively low labor supply and high wages affect the labor-dependent farm production function, encouraging mechanization to save labor. In contrast, if land were to be abundant, the higher mechanization might be explained so as to increase farm scale. This was the case for the United States in the first half of the 1900s, where (the choice of) adopting a tractor was motivated to allow an increase in the scale of farming to increase both the amount of land harvested and crop yields (Olmstead and Rhode, 2001).[6] Thus, a deeper analysis of the relative quantities of land and labor, together with their regional disparities, helps understand the origins of agrarian structures.

In this Chapter I argue that labor abundance was key to agricultural innovation, allowing to offset land aridity in the frontier regions and engage in cereal production. By taking advantage of annual agricultural statistics reported by the French administration at the municipal level in Constantine in 1904/05 and 1913/14, this chapter assesses in a simplified way the relative agricultural techniques based on the factor endowment intensities. It provides a comparative view based on the period of settlement, thus accounting for the institutional land size restrictions and land aridity. The purpose is to facilitate the understanding of Algeria's rural settlement by relating farm size and factor proportions, arguing that the regional average farm-size variation mirrors what Olmstead and Rhode (1993, p. 112) defined as "a fossil record, capturing the production choices made as the region reached maturity." This permits an examination of the role of agricultural intensification regarding land use and rural techniques, contributing to the settler-economy literature, and Gareth Austin's "de-compression of history" (Austin, 2008).

Based on the induced innovation hypothesis – a model first developed by Hicks (1932) and extended to agricultural economics by Hayami and Ruttan (1971) – this chapter first assesses technical change highlighting the role of land, labor, and capital (and their prices) as key constraints on agricultural production within wage-dependent estates. This model considers that innovations are developed to economize the relatively scarce factors. In line with critics to the model, I include the timing of settlement to explain the different farming systems.[7] Finally, as this

[4]These areas were subject to higher climatic vulnerability and irregular yields (drought, late frosts in spring, hail, or very hot climates).

[5]As an illustration, Boserup's (1965, p. 32) quote reflects how the availability of labor can shape the incentives to switch into a more intensive crop rotation frequency:

> Unless he [the peasant] keeps a large herd of domestic animals and uses much labour to collect their manure, prepare composts and spread it carefully in the fields, he is likely to obtain much lower crop yields per hectare under short-fallow systems or annual cropping than by cultivating the same land under the system of forest fallow.

[6]The authors find that the causality was bi-directional as a higher scale also induced the adoption of the tractor.

[7]Olmstead and Rhode (1993) state that the model fails to fully account for agricultural development and innovation as it relies uniquely on factor prices and market signals. They argue that, at a regional level in the United States, the factor prices went in the opposite direction as the one predicted by the model, and only at an aggregate level for the whole country does the ratio of factors support Hayami and Ruttan's arguments. They find that the

model is limited to wage-dependent estates, the section then compares modes of productions in three municipalities with only large landholdings and reviews Lützelschwab's (2006) case study of a large farming estate (the CGCS), to develop an insight into the type of farming dependent on indigenous sharecropping.

3.2 New World Conditions in an Old World Market

As argued in Chapter 1, the international prices and the colonial tariff regime assumed a vital role and influenced settlers' production choices. They help explain the colonial market shift towards wine and cereal production and the boost in exports after the 1870s. However, to explain the relation between the settlement process and agriculture, it is necessary to understand the evolution of the organizational farming structure during the period. This is of particular interest as Algeria can be classified as a case of a settler economy framed in an Old World market under New World conditions.

The higher international market integration at the end of the nineteenth century led to very different forms of farming. For example, as explained by Offer (1991, p. 105), in an Old World wheat importing country such as Great Britain, only few farmers worked the land they owned and tenant farmers farmed the highest share of holdings. The size of grain producing farms averaged below one hundred hectares, and most of the farmers working their own land owned less than 20 hectares and only a few possessed more than 120 hectares. The size of family farms was limited and the farming structure consolidated an unequal three-class system – landowners, tenant farmers, and farm laborers – characterized by high shares of labor supervision, rent incomes, and soaring land prices. However, even within grain exporting regions there were also strong differences in the forms of farming. On the one hand, in regions like Russia, India, and the Danube, the new international grain flows led to peasant farming with "land shortage and high rents, a surfeit of mouths to feed, taxation, usury, political oppression, poor communications, illiteracy and apathy." On the other hand, in the New World grain suppliers farmers had "sufficient land, draft animals and machinery, cheap credit, literacy, enterprise, education and scientific support" (Offer, 1991, p. 87). The latter, defined by Offer (1991) as the prairie farmer figure, was characterized by a new social form endowed with cheap and available land, self-exploitation or efficient family units, low production costs, and small-scale economies, where the lack of power and no laborer-manager-landowner division led to more equal societies.

Thus, to understand Algeria's farming structure, it is first necessary to examine where did the colony situate in terms of land availability. Table 3.1, obtained from Malenbaum's (1954) estimates, provides a general comparative idea about the international categorization of the wheat-exporting countries, classified in "overseas," "European," and "extra-European." It shows that the total wheat-devoted acreage experienced a strong expansion in the USA, USSR, Argentina, and

more settled areas had more stable land-to-labor ratios, but the frontier areas experienced rapid increases in land prices. Thus, the authors conclude that the model must include the analysis of the settlement process.

Table 3.1: Wheat acreage (in hectares) and total production (in quintals) from Malenbaum (1954), grain exporting countries 1885-1914

Countries	Wheat Area (5-year averages, million of hectares)						Wheat Production (millions of quintals)					
	1885-89*	89-94	94-99	1899-04	04-09	09-14	1885-89*	89-94	94-99	99-04	04-09	09-14
Argentina	0.81	1.40	2.51	3.59	5.62	6.50	5.22	12.87	16.22	25.39	43.03	40.04
Australia	1.34	1.41	1.73	2.20	2.35	3.08	7.05	8.52	7.43	11.62	16.14	24.63
Canada	1.04	1.17	1.47	1.68	2.28	4.03	10.42	11.13	14.10	20.85	28.31	53.65
USA	19.65	21.31	22.45	23.88	20.81	21.82	140.34	171.01	186.85	194.28	182.85	189.00
Total	22.84	25.30	28.16	31.34	31.06	35.41	163.23	203.54	224.61	252.15	270.33	307.32
Bulgaria	0.78	0.79	0.82	0.82	0.97	1.08	7.49	9.85	8.76	8.44	9.58	11.49
Hungary	2.93	3.25	3.29	3.59	3.73	3.68	36.12	39.14	38.87	43.36	44.69	46.16
Rumania	1.18	1.44	1.48	1.59	1.85	1.85	12.49	14.97	15.13	16.82	20.20	23.90
Yugoslavia	0.22	0.28	0.29	0.34	0.37	0.38	1.52	2.40	2.61	2.75	3.05	3.35
Poland	0.40	0.50	0.52	0.52	0.50	0.51	3.38	4.33	5.06	5.17	5.55	6.34
USSR	17.67	18.73	19.99	23.69	26.98	31.07	97.31	98.09	123.08	148.37	168.84	215.49
Total:												
Incl. USSR	23.17	24.99	26.38	30.55	34.41	38.57	158.30	168.78	193.52	224.90	251.91	306.72
Excl. USSR	5.50	6.26	6.39	6.86	7.42	7.50	61.00	70.69	70.44	76.54	83.07	91.24
Algeria	1.26	1.25	1.28	1.35	1.38	1.43	6.15	6.21	6.91	8.49	7.97	9.55
Morocco	0.42	0.44	0.46	0.48	0.52	0.56	2.86	2.97	3.10	3.24	3.48	3.76
Tunis	0.40	0.40	0.40	0.42	0.43	0.53	1.36	1.55	1.93	1.44	1.52	1.69
Chile	0.40	0.40	0.40	0.35	0.44	0.42	3.89	4.79	3.51	3.24	4.16	5.47
Uruguay	0.17	0.17	0.25	0.28	0.29	0.31	1.22	1.36	1.69	1.66	1.91	1.85
Indian Penin.	11.02	10.69	10.23	9.29	10.95	11.83	72.35	67.28	65.49	67.77	82.12	95.75
Total	13.68	13.36	13.03	12.17	14.01	15.08	87.83	84.16	82.63	85.85	101.17	118.07

In contrast to the original source, I changed acres to hectares (1 acre = 0.405 hectares) and wheat bushels to quintals (1 quintal = 3.675 wheat bushels); Morocco refers to French Morocco; * 4-year average. *Source*: Malenbaum (1954, p. 236-239).

Canada between 1885 and 1914. Yet, if we exclude the USA, USSR, and the Indian peninsula from the sample, then it demonstrates that during the first years Algeria was positioned well above the other extra-European countries and situated just behind Hungary and Australia in terms of total extension. However, acreage virtually stagnated throughout the period, with only a slight increase of 13.5 percent. This is very different from Australia, for example, which began with a similar value but increased by 129 percent in the same period. Hence, although these aggregated figures must be regarded with caution, they suggest that cultivable land was scarce in contrast to the New World countries and already by the 1870s the frontier expansion had been nearly exhausted in Algeria.

Hence, given the limited amount of arable land, what happened to the ratio between land and labor? Table 3.2 shows various indicators relating land and rural population at a district level in Constantine. The first three columns show that, on average, less than half of the total municipal area was cultivated, while more than 50 percent was owned (without changing significantly between 1904 and 1914). The low shares of the cultivated area among the hectares owned are explained by the high land aridity levels encountered in French Algeria. With respect to the cultivated hectares per capita (that is, including both indigenous and Europeans in rural areas), the values range from 1 hectare per person to almost 5 (see column *All* under *Cultiv/AgrPop*). If we

compare these figures to the ones reported in Simpson (1987) for 1880 and 1930,[8] Constantine's amount of cultivated land per laborer was below the one in Spain (3.63 in 1880 and 5.70 in 1930 respectively), Germany (6.34 and 6.46 respectively), and France (6.96 and 8.80). It was above that of Japan (though not far), (0.66 and 0.91), and was significantly lower than the values reported for Great Britain (14.7 and 17) and the United States (25.4 and 40.5). However, if we restrict the observations to the settler population (that is, the settler cultivated area divided by the rural settler population) as shown in column *Eur.*, we can see that the values are significantly higher, demonstrating that – if Algeria had been empty of local populations since French arrival – settlers per se would have been relatively labor scarce. Yet, in contrast to the New World "prairie" family farms, land was not abundant and settlers heavily relied on indigenous laborers and sharecroppers. Thus, in line with this, if we add to the denominator of *Cultiv/AgrPop* the amount of indigenous wage labor (column *Eur.&Ind.Labor(I)*) and sharecroppers (column *Eur.&Ind.Labor(II)*), one can see that at the beginning of the 1900s Algeria positioned within the labor abundant/land scarce type of settler farming.

Table 3.2: Total rural population densities per district, Constantine in 1904/05 and 1913/14

District	Share Cultiv. (1)	Share Owned (2)	(1)/(2)	Cultiv/AgrPop				Size Property	Share Prop.>41ha
				All	Eur.	Eur.&Ind. Labor(I)	Eur.&Ind. Labor(II)		
				1904					
Batna	0.25	0.50	0.57	4.46	12.40	4.24	1.99	39.09	0.32
Bone	0.20	0.66	0.34	1.00	3.40	1.12	0.88	20.74	0.10
Bougie	0.35	0.68	0.52	1.90	10.75	1.72	1.40	47.96	0.48
Const.	0.41	1.00	0.52	1.80	17.87	2.90	1.49	48.85	0.44
Guelma	0.28	0.69	0.45	1.28	7.13	2.55	1.01	41.80	0.34
Philip.	0.26	0.71	0.37	2.06	8.80	1.70	1.33	28.41	0.24
Sétif	0.44	0.76	0.57	2.08	17.03	5.61	1.95	51.84	0.51
				1913					
Batna	0.33	0.55	0.56	4.69	12.60	4.70	2.41	40.25	0.33
Bone	0.26	0.67	0.43	1.43	4.92	1.24	1.14	27.83	0.17
Bougie	0.26	0.65	0.40	1.83	8.23	1.64	1.09	47.14	0.46
Const.	0.48	1.10	0.55	1.68	18.65	3.12	1.65	54.42	0.51
Guelma	0.26	0.61	0.43	0.93	7.43	2.48	1.22	40.49	0.33
Philip.	0.29	0.77	0.38	1.79	11.08	1.61	1.24	31.04	0.24
Sétif	0.46	0.83	0.54	1.65	15.85	6.05	1.79	54.14	0.53

Share Cultiv. is the ratio between European and indigenous cultivated hectares over the municipality's total area in 1902; *Share Owned* is the ratio between European and indigenous owned hectares over the municipality's total area in 1902; *(1)/(2)* is the ratio between *Share Cultiv* and *Share Owned*; *Cultiv/AgrPop* is the ratio between: i. European and indigenous cultivated hectares over total rural population (column *All*), ii. European cultivated hectares over European rural population (column *Eur.*), iii. European cultivated hectares over European rural population plus indigenous wage labor (column *Eur.&Ind.Labor(I)*) and, iv. same as *Eur.&Ind.Labor(I)* plus indigenous sharecroppers in the denominator (column *Eur.&Ind.Labor(I)*).[9] The *Share Prop>41ha* are the weighted means (based on the settler rural population) of the share of properties above 41 hectares; *Size Property* is the European average property size in hectares per municipality. *Source*: SA (1904/05, 1913/14), Busson (1898), and ANOM-iREL. See Appendix D for more detail on sources.

[8] Based on Binswanger et al. (1978) and Simpson's calculations for Spain. For more detail see Simpson (1987).

Indeed, in colonial Algeria the land-to-labor ratio strongly shaped agricultural production: the relative labor abundance in the frontier was key to innovate and overcome land scarcity, allowing to engage in cash crop production. [10] The introduction of new farming techniques – i.e., changes in crop rotation frequency and more intensive preparatory plowing – allowed wheat production to increase yields and expand beyond the Northern fertile areas.[11] These techniques allowed for the succession of crops in the same plot (whereas previously a part was left fallow) thanks to the combination of superficial (10 to 15 cm) and deeper plowing (from 20 to even 40 cm) that preserved the moisture, avoided excessive soil erosion, and increased wheat yields.[12] Adopting these new methods necessitated more intense labor, modern European plows (not labor saving), and stronger draft animals (see Figure 3.3) (Lützelschwab, 2000).[13]

Thus, although labor abundance was key to agricultural innovation, capital was also a major constraint. The modern plows were not only more expensive but, as shown in Figure 3.3, they required stronger and hence more expensive draft animals in contrast those used with indigenous plows. This also affected livestock as the new methods removed the fallow fields used for animal feeding. Hence, cash crop cultivation in less fertile areas was more expensive. This is visible in a detailed explanation by Trabut and Marès (1906) listing extensive costs (fixed, annual, and per hectare) required to establish a 200 hectare farm in the High Plains. To cultivate 100 hectares, as a fixed cost, the settler would have to buy land (40,000 francs),[14] 12 horses or mules (3,600 francs), 4 big modern plows for deep plowing (800 francs), around 7 small plows for the superficial work (600 francs), and approximately two reapers (6,000 francs). Farming also required the construction of a stable and a house at a cost of 6,000 francs. In addition, the corresponding annual costs to sow 100 hectares would require animal feeding (4,380 francs), labor (2,500 francs), reparations and machinery depreciation (1,500 francs), seeds (2,000 francs),

[9]The data on sharecroppers does not allow to distinguish between those cultivating European lands and those cultivating indigenous-owned lands. Thus, I calculated the mean share of the total land owned by Europeans (approximately 20 percent) and multiplied the latter by the total number of indigenous sharecroppers per municipality (assuming that indigenous sharecroppers equally distributed their work among all the cultivated area).

[10]Settlers initially struggled to adapt to Algeria's climate and new environment (Mollard, 1950). Algeria's climate was similar to that of Spain which, as Simpson (1996) explains, was very different from Atlantic Europe and was not able to engage in the agricultural revolution because of land aridity. The latter restricted the diffusion of new crops and pastures that permitted higher husbandry densities.

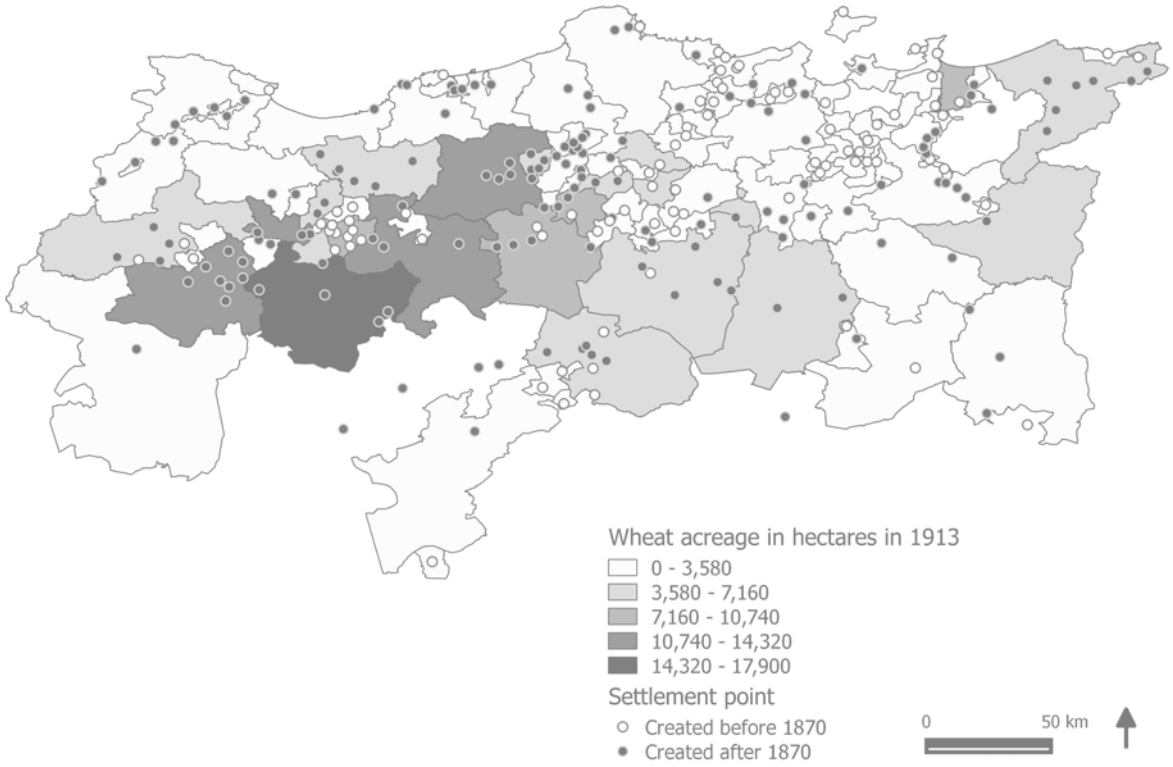
[11]The recovery of wheat prices, the tariff assimilation policy, and changes in credit and infrastructure also helped expanding cereal cultivation.

[12]These techniques, known as preparatory plowing, were already present in Algeria prior to French arrival. They were implemented by the Carthaginians and Romans and somehow forgotten in the nineteenth century. They permitted cereal cultivation below 500 mm of yearly rainfall (though, when it was below 400 mm, other crops such as alfalfa had to be planted) (Mollard, 1950). For detail on the methods used in French Algeria see Trabut and Marès (1906). The season for preparatory deep plowing was in December and January, the superficial plowing in March, and the sowing of different cereal crops in Autumn. Lützelschwab (2000) explains that in a three-year rotation system, which was the one used at the beginning of the 1880s by the CGCS, land was cultivated with winter cereal in the same plot during two successive years and then, during the third year, the plot was left to lay fallow. The use of fertilizers was limited to the areas with more advanced cultivation such as Sidi bel Abbés (Mollard, 1950).

[13]This was similar to the settlers of the American Great Plain. Dry-farming necessitated extensive plots and more intense land use methods to compete in the global market, ultimately affecting the scale of farming. For more detail on the dry-farming methods on the Great Plains see Libecap and Hansen (2002).

[14]Assuming the price of the hectare is 200 fr.

Figure 3.2: Total wheat acreage in hectares per municipality, Constantine in 1913/14



The data is classified according to equal intervals. *Source*: SA (1913/14), Busson (1898), ANOM-iREL. For details on map sources and spatial aggregation see Appendix D.

and capital interests (4,133 francs), as well as other general costs (1,500 francs). Finally, the cost for all the agricultural labor tasks per hectare, such as plowing, sowing, and *planchage*,[15] harvesting, etc., would equal to approximately 160 francs per hectare. Hence, although rural credit was facilitated after 1901 when the regional banks (*Caissés Régionales de Crédit Agricole Mutuel*) were created,[16] access to land and agricultural production in semi-arid areas was barely affordable for family units and small rural settlers.

Cereal cultivation had been displaced and pushed south into less fertile areas due to the introduction of viticulture (Mollard, 1950). Indeed, although cereal represented the highest share of the total cultivated area in all three departments, viticulture played a key role in Algeria's agricultural development and was considered to have consolidated settlement in the long run (Isnard, 1947, 1975). Many settlers turned to wine production as a response to the international cereal price drop and the *phylloxera* vineyard disease in France.[17] Yet, as Meloni and Swinnen

[15] *Planchage* was the use of a three-meter board to avoid water evaporation.

[16] These credit institutions regulated financial flows going from the *Banque de l'Algérie* and the colonial Administration to the local banks that provided agricultural credit to individuals. Griffin et al. (2002) explains that the credit system reflected the dualism between both the indigenous and settler populations. Indeed, the role of the credit institution created in 1893 for the Algerian population – known as S.I.P (*Sociétés Indigènes de Prévoyance*) and later as S.A.P (*Sociétés Agricole de Prévoyance*) – has been severely criticized and questioned Griffin et al. (2002).

[17] Isnard (1975) states: "It is not exaggerated to say that Algeria was saved, in that occasion, by an insect."

(2014) explain, in Algeria winegrowers struggled as production in warm climates required advanced technology to complete the fermentation process. Production became possible after the mid-1850s because of Pasteur's scientific innovations (i.e., known as "cold fermentation") which, together with trade regulations, allowed wine to represent "half of the Algerian exports and almost one third of [its] GDP" and helped Algeria becoming the first exporter to France (Meloni and Swinnen, 2014, p. 10). Algerian viticulture specialized in cheap table wines and relied on modern machinery and intensive labor. The settlers' demand for cheap wage indigenous labor boosted in the 1880s as wine prices dropped due to its production recovery in France (Ageron, 1991; Isnard, 1949; Belkacemi, 1984).[18] According to Isnard (1959), in contrast to cereal cultivation that relied more on sharecroppers, viticulture was more labor intensive and absorbed almost entirely the waged labor. It produced economies of scale and was mostly characterized by large, capital-intensive wineries, departing from the Old World, small-family type of vineyards (Simpson, 2011a).[19] Thus, in comparison to the Old World where the entry costs were low, engaging in viticulture in Algeria and owning a vineyard was also expensive (e.g., installing a wine cellar) and labor intensive.[20]

In summary, international prices and the tariff policy assumed a vital role and influenced settlers' production choices. They help explain the colonial market's shift towards wine and cereal production. Protective French tariffs positioned Algeria in a privileged position that allowed the country to greatly increase exports after the 1870s (as New World countries), despite the evident lack of cultivable land (as Old World countries), and this affected the organizational farming system. Land scarcity and labor abundance marked the beginning of an organizational structure which, according to many, laid the groundwork for an agrarian economy very different to what was initially expected. In particular, cereal cultivation in the later settled frontier regions – which, as shown in the previous chapter, were endowed the highest land concentration levels – required labor abundance and high capital investment, which was incompatible with the small rural peasant economy.

[18] It substituted the relatively more expensive settler daily laborers. The recovery of wine production in France pushed wine prices downwards so that wine producers in Algeria were forced to decrease production costs. It is found that viticulture laid the origins of wage labor in Algeria. To see a more detailed analysis regarding viticulture in Algeria and its trade with France, see Meloni and Swinnen (2014). Regarding the effects of viticulture within the Algerian society see Isnard (1975).

[19] Indeed, although in the 1880s most winegrowers (around 77 percent) were small owners, they only possessed 14 percent of the total vineyard plantations, while the owners of properties above 50 hectares (which were only 6 percent of all the winegrowers) accounted for more than half of all Algerian vineyards and harvests (Isnard, 1975). For instance, in 1863 the average property devoted to viticulture was around 1.2 hectares Yacono (1993), while in 1959 the average surface of a vineyard was of 26.7 hectares in Constantine (AAEEAA, 1990)

[20] In addition, the *phylloxera* plague raised costs as it required replanting disease-resistant vines and more delicate vines with a shorter life-span. Moreover, as Simpson (2011a) explains, "by 1900, the new wine-making techniques included refrigerators, continuous presses, aero-crushing turbines, sterilizers, and pasteurizers, and these helped create economies of scale [...]." For example, as Simpson (2011a, p. 10-11) explains based on Augé-Laribé (1907; p. 143-137), "vineyard owners in the Midi with less than 5 hectares usually worked their vines with hand hoes rather than plows. On larger properties, the vines were likely to be plowed, and those over 25 or 30 hectares needed hired labor and perhaps a manager. Vineyard of 80 hectares or more took on the characteristics of an industrial enterprise."

Figure 3.3: Indigenous and European plow in French Algeria

(a) Indigenous Plow

(b) European Plow

The photo above shows a traditional indigenous plow used for superficial land scratching, while the European modern plow shown in the picture below allowed a deeper plowing. *Source*: Clerc, Pascal (2008). *Les formes de la domination: paysages ruraux de l'Afrique du Nord colonisée*, Mappemonde, number 91 (3-2008). Retrieved from `http://mappemonde-archive.mgm.fr/num19/articles/art08302.html`. *Original Source of photo*: Gallouéec, L. and Maurette, F. (1922). *Géographie de la France et de ses colonies. Classe de Troisième*. Paris: Hachette, p. 286.

3.3 Farm Size Restrictions: "Older" vs. "Frontier"

Though farm size restrictions are explained in more detail in Chapter 2, it is necessary to briefly mention them here as well as they relate to changes in agrarian structure. The timing of land size restrictions permits the classification of municipalities into two categories: the "old" and the "frontier." This is in line with Olmstead and Rhode (1993), who argue that (in the case of the United States in the nineteenth century) the "older areas were constrained by past decisions about farm size and organization." The arrival of the French shaped the Algerian land market, and settlement was organized and managed by the colonial administration (known as "official colonization"). The year of creation of a settlement center reflects a progressive flexibility of the land regime's regulations on property size. The year 1870 is used as a benchmark – separating the older from the frontier municipalities – as it experienced the transition from a military administration to a civil one. Before the 1870s, the military administration prohibited territorial expansion beyond the northern settlement centers, and ownership was restricted by the government's concessions of free, small-size plots of land.[21] In contrast, after the 1870s, the new civil administration "realized that large tracts of land were necessary to cultivate the semi-arid areas" (Lützelschwab, 2000, p. 7) and supplied a larger amount of land (but still under land-size regulations). At the turn of the century it becomes harder to link official colonization to rural settlement due to the introduction of a land market,[22] growing land scarcity, and rising crop suitability towards large-scale production.

Figure 3.4 shows a positive relation between the presence of large ownership and the average year of settlement, as well as a boom in the number of settlements created immediately after the 1870s. The ownership share distribution (Figure 3.5a and Figure 3.5b) was biased towards larger estates in the frontier areas and smaller in the older regions (white dots in Figure 3.6).[23] Small ownership presence is clearly linked to firstly settled areas (most fertile) while larger estates located in more remote tribal areas were affected by the 1873 Warnier law (as it fragmented tribal land and boosted private land transaction).

The map in Figure 3.6 shows the locations of the areas endowed with higher levels of small properties; the municipalities settled the years prior to the 1870s (change of administration) show on average a significantly higher share of small properties (30 percent versus 10 percent)[24] and a

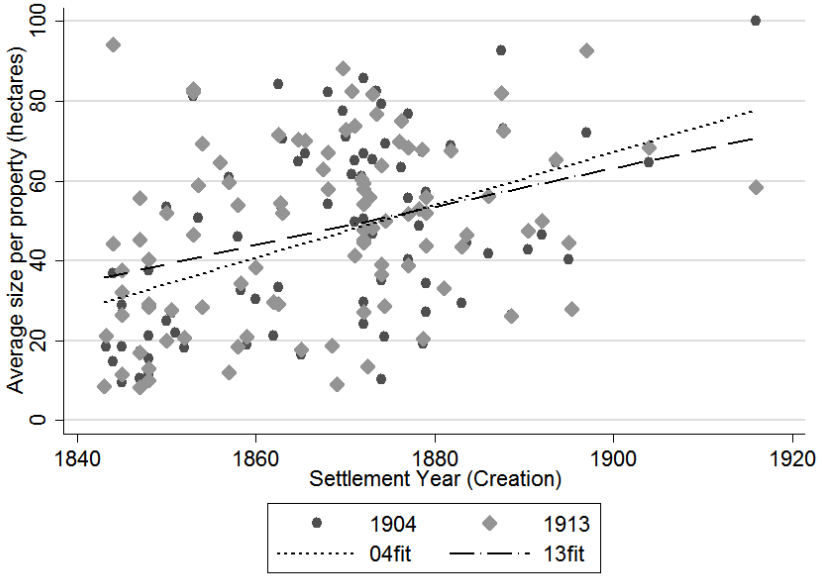
[21] The military administration "prized stability and clear channels of information-gathering, and the displacements provoked by settler colonialism were not germane to such goals" and its "limited tolerance for the bourgeois ideals of private property and the free circulation of people and goods (...) complicated the picture" (Sivak, 2008, p. 97).

[22] The 1873 Warnier law began a free land market between indigenous and settler population, fragmented tribal land, and expanded the French civil code.

[23] The average for municipalities settled prior to the 1870s is of 41.06 and after is of 51.29 hectares. The average size of property is always smaller in CPE municipalities (mean value of 43.15 hectares) in comparison to CM (mean value of 54.98 hectares).

[24] Small properties include the number of properties below ten hectares. A t-test on the mean difference is significant at a 1 percent confidence level (under the equal and unequal variance assumption). I have aggregated the 1904/05 and 1913/14 observations, but the test is also significant for each individual year. The number of observations is 99 for the older regions and 98 for the frontier.

Figure 3.4: Average property size and year of creation of settlement centers, Constantine in 1904/05 and 1913/14

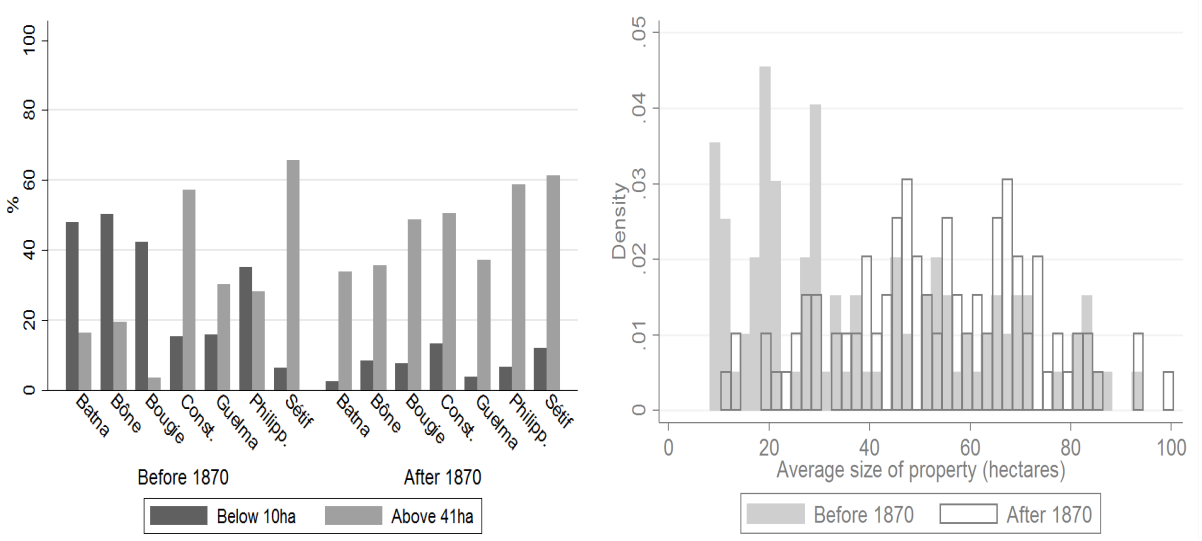


The lines *04fit* and *13fit* are the trend lines for the years 1904/05 and 1913/14. The *Average size per property* is the European average property size (or *AverSizeperProp(1)*) in hectares per municipality. *Settlement year* (or *Creation*) is the average year of creation of a settlement center within a municipality. *Source*: SA (1904/05, 1913/14), Busson (1898) and ANOM-iREL. See Appendix D for more detail on sources.

Figure 3.5: Share of properties by size and average property size density per period of settlement, Constantine in 1904/05 and 1913/14

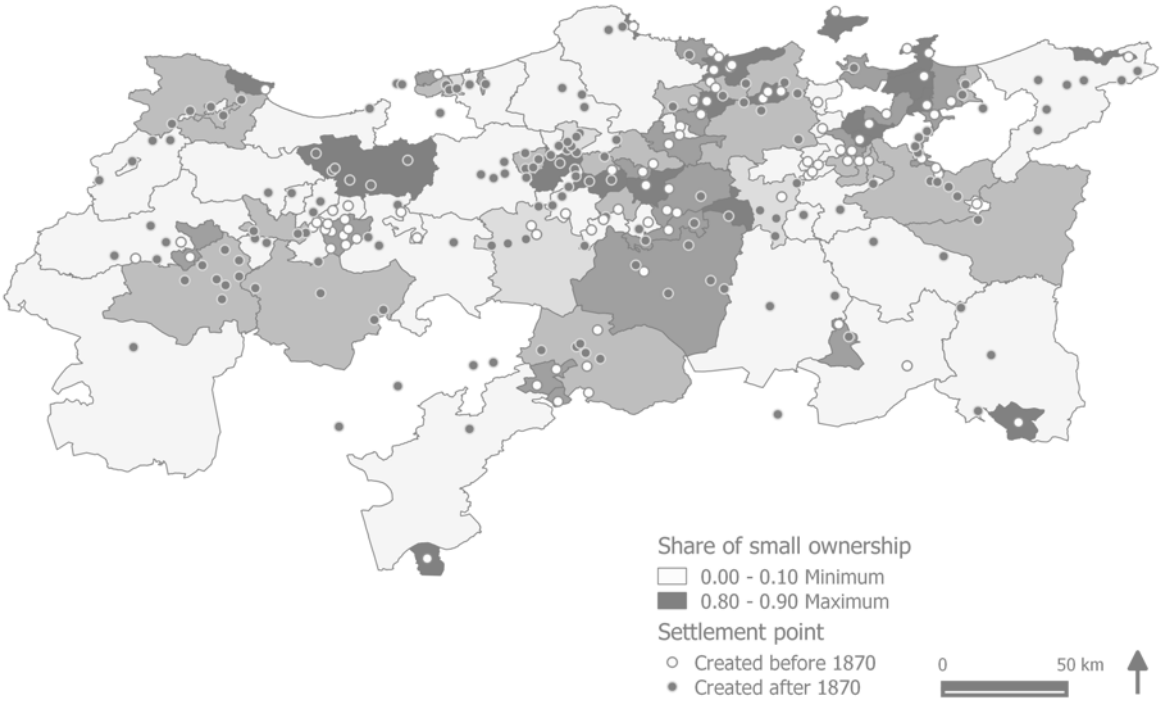
(a) % of small and large properties per district

(b) Average property size density



Small landholding are those below 10 hectares and large landholdings are those above 41 hectares. *Source*: SA (1904/05, 1913/14), Busson (1898) and ANOM-iREL. For details on map sources and spatial aggregation see Appendix D.

Figure 3.6: Share of settler-owned small properties over the total number of properties, Constantine 1904/05 and 1913/14



The data is classified according quantiles (equal count). Small landholdings are those below 10 hectares. *Source*: SA (1904/05, 1913/14), Busson (1898), ANOM-iREL. See Appendix D for map sources (CEPC and CVC) and details on spatial aggregation with GIS software.

lower share of large properties (35 percent versus 50 percent)[25] Using an index reflecting the overall distribution of properties according to their size (and setting to one-hundred the upper bound limit to the highest average size of large property), one can see that the average size is higher in the later settled municipalities, going from an average of 45 hectares to 47. The following histograms show that the data approximate a bimodal distribution given that the density of the later settled municipalities ranges around a higher mean, while the density of frontier municipalities skews towards smaller size.

3.4 The Factor Endowments: A Comparative Approach

Proving that Algeria's colonial rural economy had a relative low land-to-labor ratio does not explain why land concentration was high. Thus, this section analyzes whether the frontier regions, endowed with the highest shares of large landholdings, responded differently to relative

[25]Large properties account for properties above 41 hectares. A t-test on the mean difference is significant at a 1 percent confidence level (under the equal and unequal variance assumption). I have aggregated the 1904/05 and 1913/14 observations, but the test is also significant for each individual year. The number of observations is 99 for the older regions and 98 for the frontier.

production factors and their prices as opposed to the earlier settled regions. For this reason it first assesses, based on the period of settlement, the dynamic process of regional adaptation to more advanced agricultural techniques (i.e., mechanization or land use methods) among the large, wage-dependent properties. To do this, I apply Hayami and Ruttan's Induced Innovation model to compare the relative production factors between the frontier and older municipalities. Given that this model limits the analysis to wage-dependent estates, the analysis is complemented with a comparative study of three municipalities with only large landholdings to get an insight to the type of farming found in addition to wage-dependent estates. To conclude, as an example of large estates that relied on indigenous sharecropping, I summarize the case of the CGCS studied by Lützelschwab (2000). I argue that labor abundance helped offset the worse land quality in the frontier; yet, the capital needed for cultivation and the progressive withdrawal of official colonization (as argued in Chapter 2) help explain the crowding out of small family settlers.

The frontier regions engaged mostly in cereal cultivation; as stated by Lützelschwab (2000), it was the only crop that allowed cultivation under "a capitalist perspective" in arid climates. Thanks to dry-farming, the French administration was able to provide at the beginning of the 1900s new and uncultivated lands for cereal cultivation to settlers in the High Plains. Thus, the cultivated area expanded to the surroundings of Constantine, Batna, Guelma, Sétif, Mostaganem, Sidi-bel-Abbès, Miliana, and Orléansville, and, in all of Algeria, it was augmented by 170,000 hectares between 1905 and 1915 (Mollard, 1950). In the case of Constantine, European wheat cultivation expanded from 160 thousand hectares in 1898/1902 to 209 thousand in 1906/1910 (Lützelschwab, 2000).[26] In line with this, the agricultural statics for Constantine in Table 3.3 indicate that the share of wheat over the total cultivated area was greater in the frontier regions, with a difference of more than ten percentage points. Viticulture, on the other hand, represented a small portion of the cultivated area and the share difference of vineyards over the total area between the older and frontier regions is not significant.[27] Figure 3.7 shows the differences in the average share of each crop (wine or wheat) and its total extension based on the period of settlement (before or after 1870).

Concerning the labor market, a first glance at the data from the agricultural statistics shows that the daily indigenous labor force employed during the agricultural seasons was relatively smaller and more expensive in the older areas (Table 3.3).[28] These results suggesting a higher supply of indigenous labor in the frontier are in line with Algeria's colonial history. The latter was prompted after the 1870s as a result of colonial land policies, steady population growth, and the failed Kabylia rebellion in 1871, forcing the impoverished local populations to search for

[26] In 1881/85 it was 2,837 thousand hectares, 2,749 in 1888/92, 2,836 in 1898/1902, and 2,902 in 1906/1919. The values are five year averages. From Lützelschwab (2000), the original source of the data is the SGA.

[27] The mean for the older regions is 0.097 percent and for the frontier regions is 0.126. The mean difference is not significant both under the unequal and equal variance assumptions.

[28] There is a negative and significant correlation between the year of settlement and indigenous wages per day. The indigenous labor per day, which reflects the number of workers employed, shows a high dispersion. Values range from a minimum of 0.03 workers per day to a maximum of 1.24.

additional sources of income.[29] As an illustration, Ruedy (2005, p. 98) describes that "in the last years of the Second Empire, settlers had been surprised, for the first time, to see large numbers of natives searching for work in the colonization centers," and Belkacemi (1984, p. 245) stated that "repressive military, fiscal and land policies resulted in the post 1871 period, in the disintegration of traditional peasant structures and the availability of a large supply of manpower." The frontier regions were particularly affected as colonial land policies pushed indigenous populations from the fertile coastal regions into the inland semi-arid areas (i.e., the frontier) (Griffin, 1976, p. 16). In addition, the outcome of the 1871 rebellion in favor of the French resulted in severe sanctions – money contributions and land sequestrations – that increased the indigenous labor supply in the hinterland Kabylia regions, the plains of Sétif, and the Eastern areas in the proximities of Aïn Beïda, and Batna.[30]

However, these data must be analyzed with caution as it is available at an aggregated annual basis, and thus it is not possible to account for seasonality which was particularly strong in Constantine. As explained by Nouschi (1961), labor employment in Constantine was mostly seasonal and relied on both daily wages and piecework (service provided independent of time). The author explains that wages per day ranged between 1 and 3 francs, with a mode fluctuating around 1.50 and 1.75 francs, while piecework could vary from 20 francs per hectare (if harvested using a sickle) up to 110 francs per hectare (for grape harvesting). Accounting for seasonality would allow a deeper understanding of land use systems and size of farming. For instance, the transition from a three-field rotation system into a two-field intensive one (with no plot left fallow) increases seasonality as it requires a higher number of workers because of the more intensive preparatory plowing techniques at certain times of the year (Sumpsi, 1975).[31]

With respect to the land market, Table 3.3 demonstrates that land prices (average land value of one hectare of non-cleared land) were relatively cheaper in the frontier; despite numerous missing observations, a t-test on the mean differences shows that these were significantly lower.[32] This is logical given that the frontier had a lower settler occupation per colonized hectare (see Table 3.3) and an average lower land quality, that is also reflected in significantly inferior annual cereal yields (see Figure B.1 in Appendix for detail on geographic distribution).[33] In addition,

[29]The laws passed in 1873 and 1887 permitted the land commercialization that facilitated the fragmentation of indigenous communal lands. This partition of land clashed with indigenous population growth so that the per capita size of property decreased, forcing local populations to search for additional sources of income.

[30]A dummy variable for these regions (equal to one if Kabylia, equal to zero if others) is positively and significantly correlated to the municipalities with higher quantities of annual labor employed during the agricultural seasons.

[31]The author studies Andalusian large estates in the beginning of the 1930s to understand the labor productivity implications of capital gains experienced from changes into more intensive agricultural techniques. Sumpsi's (1978) article is very useful as it recreates different farming systems based on hypothetical 1,800 hectares farms in the Andalusian region. As the Constantine region, particularly the frontier regions, Andalusia is of particular interest as it is characterized by drylands and experienced similar changes in the rotation system.

[32]Values are consistent for cleared and non-cleared hectares, and annual (*fermage*) tenancy rates. The mean difference in land prices becomes stronger if the test is applied for the municipalities of CPE (a mean equal to 210.6 francs per hectare) versus the CM (103.1 francs per hectare); assuming unequal variances, the difference is significant at a 95 percent confidence level.

[33]The pair-wise correlation between the crop suitability index and land prices is negative and significant at a

with regard to cereal cultivation, the evidence shows that the cultivated area per property was more extensive in the regions settled later in time.[34]

Figure 3.7: Share and extension of the wheat-cultivated area and viticulture by year of creation of settlement centers, Constantine in 1904/5 and 1913/14

(a) Share of cultivated crop (b) Area cultivated in hectares

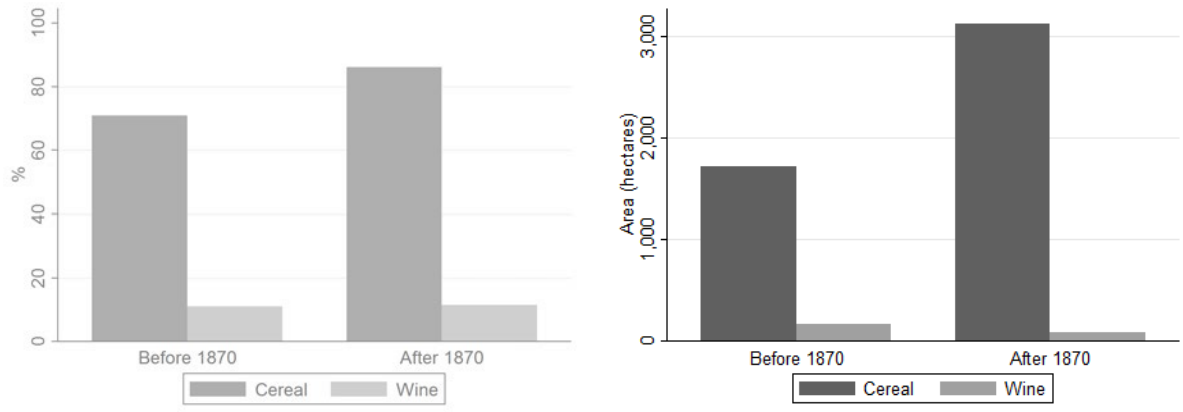


Figure (a) is the average share of the area cultivated of wheat or wine over the total area cultivated in the municipality. Figure (b) displays the average total cultivated area in hectares of wheat and wine per municipality. *Source*: SA (1904/05, 1913/14), Busson (1898), ANOM-iREL. See Appendix D for more detail on sources.

Table 3.3: Factor prices and quantities, Constantine 1904/5 and 1913/14

Region	Mean Prices		Quantity			Land	Land	"Innovation"	
	Land (fr/ha)	Labor (fr/day)	Share Cereal	Settler per col. hectare	Lab. per day	to Labor (I)	to Labor (II)	Mach. per hectare	Share land Europ. mode
Older	218.47	1.83	0.70	0.06	0.03	11.03	21.56	0.004	0.50
Frontier	135.87	1.64	0.83	0.04	0.06	5.46	17.16	0.001	0.33
P-value	0.042**	0.004***	0.006***	0.005***	0.033**	0.004***	0.224	0.024**	0.001***

* p<0.1; ** p<0.05; ***p<0.01. The values are shown for unequal variances although significance level is the same under the equal variance assumption. The variable *Land* is the average value of one European-owned hectare of non-cleared hectare; *Labor* refers to daily indigenous labor; *Share Cereal* is the European share of wheat cultivated hectares over the total European number of cultivated hectares; *Settler per col. hectare* is the rural settler population over the number of hectares of the settlement centers in the municipality (estimated with the 1902 CCO map and GIS software); *Lab. per day* is the daily indigenous labor; *Land to Labor (I)* is the ratio between the number of European cultivated hectares and the number of indigenous laborers; *Land to Labor (II)* is the ratio between the number of the European cultivated area in large landholdings over the number of indigenous laborers; *Mach. per hectare* are steam tractors per cultivated hectares; *Share land Europ. mode* is the number of hectares cultivated *à la mode Européenne*. *Source*: SA (1904/05, 1913/14), Busson (1898), ANOM-iREL. See Appendix D for more detail on sources.

Thus far I have set forth the relative differences in quantities and prices of land and labor. The results suggest that cereal farming in the frontier relied on more extensive cultivation and cheaper indigenous labor to produce similar (or lower) yields as the ones obtained in the earlier settled regions. In other words, agricultural innovation was introduced to offset the worse land quality and allow cash crop production in semi-arid areas. However, in order to understand what drove settler production functions it is also necessary to analyze the land-to-labor ratio. This is more

one percent significance level.The winter cereal yield is 9.5 grains (quintals) per cultivated hectare in the older municipalities and 8.1 in the frontier.

[34]By calculating the ratio between the European wheat cultivated area and the number of properties (or settler owners), it is possible to get an idea of the average cultivated extension per property (or settler owner). The correlation os positive and becomes significant at a one percent confidence level confidence level.

complicated given that the agricultural data used (that is, the SA for 1904/05 and 1913/14) gives information on the total number of laborers, days worked, and wages, but it does not provide data on the corresponding area cultivated by such laborers. Table 3.3 shows a broad estimate of the land-to-labor ratio (*Land to Labor (I)*) reflecting a significantly higher value for the older municipalities (see Appendix B for detail on construction). Yet this estimate is inaccurate as the numerator includes the cultivated hectares for all types of properties, both small and large. The problem is that these two farming units cannot be aggregated as they will make different production decisions based on a given set of factors. That is, small family farms are not directly affected by wages as they do not employ laborers. Hence, I create a more precise estimate (*Land to Labor (II)*) by restricting the numerator to the properties that most likely relied on waged labor. Based on Sumpsi (1978),[35] I argue that wage-dependent farms can be proxied by those above 40 hectares.[36] The results show that the *Land to Labor (II)* is still higher for the older municipalities, but it is not significantly different, allowing one to conclude that the number of estates relying on daily labor during the high seasonal peaks did not differ significantly between both areas (which is likely justified by seasonal labor force mobility).[37] However, the *Land to Labor (II)* variable must also be regarded with caution, not only because Sumpsi's values are estimates and correspond to different regions that probably differ on the timing of tillage and harvesting, but also because the estimates are limited to cereal cultivation and thus a 40 size benchmark overestimates that of viticulture which was more dependent on seasonal wage labor.[38]

Thus, once we know the relative prices and quantities of land and labor, it becomes possible to finally test Hayami and Ruttan's Induced Innovation model (Hayami and Ruttan, 1971). This model allows examining how wage-dependent estates responded to the relative factors of production. The key point is that technological change allows the substitution of the relatively scarce input for the abundant one in a given economy; i.e., if labor is scarce relative to land, then the innovation is labor-saving and will entail mechanization to increase the marginal product of land (for instance, as in the case of the United States and the mechanical reaper in the nineteenth

[35] Sumpsi's (1978) estimates are based on a 1,800 hectare exploitation and assume a two-field intensive rotation system with no fallow, animal traction, and seasonal labor. I rely on wheat cultivation because it accounts for the largest share of the cultivated area in Algeria.

[36] The reasoning is as follows. In line with Sumpsi (1975), a 40 hectare property would seem to require a total of around 326 daily laborers for annual sowing, which equals to 11 laborers working every day during a 30 day month (usually sowing is done in October and accounts for 20 percent of the annual daily labor used). The harvest for the same cultivated area in the month of June demanded approximately 7.4 daily laborers during 30 days. Given that the timing of harvesting was particularly critical, the demand for seasonal labor was high and included also women, children, and industrial workers (Simpson, 1987). Thus, assuming a five-unit family farm with all five members working, a plot of 40 hectares would need more than one whole family working every day throughout the month for both sowing and harvesting. Hence, a 40 hectare size seems to be a reasonable benchmark to determine the properties dependent on wage labor.

[37] This result is supported by the indigenous labor density variable (*Laborers/ha_I*) obtained from a different SA folder (see Appendix B for detail). The latter provides information on the indigenous rural population density for the different land tenure categories (and thus, it should cover the total cultivated area and not only the wage dependent farms). A t-test on the mean difference is not significant, suggesting that the regional variation in the land-to-labor ratio is not sufficient to account for the regional differences between the old and frontier large estates.

[38] For example, as Simpson (2011a) argues, the optimal vineyard size in the Midi was 60 to 80 hectares and economies of scale appeared beyond 30 hectares.

century). Based on the model, if the land-to-labor ratio is higher in the older regions, and labor and land are more expensive,[39] then it is to be expected that mechanization (and land-saving techniques) is also higher.[40] This is because technological advances are brought in to overcome factor scarcities. For example, in Algeria, the harvest of a 30 to 40 hectare lot using ten harvesters lasted a month, whereas two to three days were sufficient when employing a modern six draft-animal harvester with only two laborers (Lützelschwab, 2000).

The data confirm the prediction: the density of all agricultural instruments per hectare was higher (particularly threshers and mechanical reapers) in the older municipalities. Table 3.4 shows that the number of agricultural tools per hectare (as dependent variables) correlates most significantly (and with the expected signs) to land prices, the amount of indigenous labor employed, and wages.[41] The tractors follow a similar pattern as the other agricultural instruments. However, it is important to keep in mind that mechanization was particularly low and that meaningful changes in agricultural techniques are reflected in the adoption of modern French plows that permitted deeper plowing in the arid regions.[42] The adoption of these plows is reflected in column 5 in Table 3.4. In column 6 the dependent variable is the ratio between the number of French plows and the traditional indigenous plow used by settlers, reflecting the "modernization" level at any given scale. Yet the French plow was not a labor saving technology (see Figure 3.3). The meaningful labor saving effect comes with the mechanical reaper, which accounts for the most expensive fixed cost (together with the land purchase). The latter can be substituted by labor force while the deeper plowing necessarily requires modern plows.[43] The statistics in Table 3.3 confirm this by showing significant differences between the frontier and the older regions with respect to the mechanical reaper intensity, while insignificant regarding the European plow.[44] Finally, and consistent with Isnard (1975), the predominance of large wine properties (reflected in the variable *ShareWineArea_E* in Table 3.4) provides a powerful explanation of the high degree of technical improvement, which should be reflected in more advanced machinery, a greater number of skilled workers, and the highest share of waged labor.

To sum up, with respect to wage-dependent estates, the data and the model both show that it was relatively cheaper to expand the amount of cultivated land and benefit from a higher labor supply in the frontier regions rather than increasing the use of labor-saving machinery (in particular, mechanical reapers). However, as clarified by Hayami and Ruttan (1971, p. 19), the model is an approximation to the dynamics of the mechanization diffusion that are not as

[39] There is a negative and significant correlation between the year of settlement and the ratio of cultivated land over the number of indigenous laborers per day.

[40] Despite lack of data, Mollard (1950) argues that the use of fertilizers was limited to advanced cultivated areas.

[41] Only thresher density (column 2) does not respond to the indigenous labor variable, but this is logical as it is the sole agricultural technique in the analysis that is not seasonal (Olmstead and Rhode, 1993).

[42] Indeed, as explained by Olmstead and Rhode (2001, p. 668) in the beginning of the 1900s, tractors were still too big and unsuitable (defined as "giant steam plows"), particularly for small properties, and thus its expansion was limited.

[43] As explained by Trabut and Marès (1906), the cultivation of 100 hectares required four big European plows.

[44] A t-test for the mean difference equal to zero is significant at a five percent confidence level with a p-value of 0.0001.

Table 3.4: Mechanization in Constantine in 1904/5 and 1913/14

Dependent variable:	(1) Tractor	(2) Thresher	(3) Harvester	(4) FrenchPlow_E	(5) Instruments	(6) Modernization
L/day_I	-10.15**	10.51	-11.96*	-62.05**	-151.12**	-0.05**
	(3.00)	(17.95)	(5.36)	(17.78)	(41.18)	(0.02)
Wage/day_I	0.74	0.01	0.80	18.41**	25.99*	0.02**
	(0.54)	(0.93)	(1.80)	(6.52)	(12.69)	(0.01)
LandPrice	0.02***	0.00**	0.01***	0.05***	0.17***	0.00***
	(0.00)	(0.00)	(0.00)	(0.01)	(0.04)	(0.00)
ShareWineArea_E	0.21	18.71	0.34	230.90***	472.84***	0.23***
	(0.83)	(14.28)	(1.48)	(17.99)	(45.00)	(0.02)
DYear	0.33	-0.48	1.11	2.47	8.29	0.00
	(0.64)	(1.17)	(0.96)	(6.83)	(13.68)	(0.01)
Constant	-1.71	1.89	1.87	-4.95	48.33*	-0.02**
	(1.06)	(1.63)	(3.14)	(7.86)	(20.19)	(0.01)
N	137	135	136	136	136	137
R^2	0.72	0.03	0.10	0.70	0.66	0.66
R^2_A	0.71	-0.01	0.06	0.69	0.64	0.65

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. Cluster-robust standard errors. All dependent variables are per thousand except for *Modernization*. *Land price* is the average value of one hectare of non-cleared hectare. *Modernization* is the ratio between the number of French plows and indigenous plows per municipality. *Source*: SA (1904/05, 1913/14), Busson (1898), ANOM-iREL. See Appendix D for more detail on sources.

clear-cut as expected. For example, they explain that mechanization might also be brought in by land-saving incentives; for example, in Japan the horse plow was introduced to improve cultivating techniques so as to increase the yield per hectare, not to save labor. This also seems to be the case for the frontier regions in Constantine; that is, agricultural innovation was introduced to offset the worse land quality and improve yields.

However, the prior analysis is limited to wage-dependent large estates. Thus, to provide an additional insight of the different types of farming, I compare three municipalities endowed (almost entirely) with large properties (more than 41 hectares), settled at different moments in time, and endowed with distinct land qualities.[45]

Oum el Bouaghi (third column in Table 3.5) should reflect a region that required dry-farming as it was settled after the 1890s and has a medium soil suitability for wheat cultivation.[46] In contrast, Aïn Taghrout (second column) presents a very similar soil suitability level but was settled earlier in the 1870s (shortly after the civil administration had been established).[47] If we compare the two of them, one can see that, given a similar suitability level, the later-settled municipality – with lower yields per hectare, a far lower level of the share of land cultivated in the European style (*à la mode Européenne*),[48] an almost null or lower mechanization level, no wage

[45] Suitable hectares are defined as the number of hectares above the medium level (the index is equal to 4) for low input level rain-fed wheat from the IIASA/FAO Global Agro-Ecological Zones Database.

[46] Within the municipality, one settlement center was established in 1893 and the other in 1901.

[47] One settlement center was established in 1872 and another in 1875.

[48] It accounts for the cultivated area according to the cultivation method. Constantine's agricultural data provides unusual information on the distribution of the cultivated area according to the cultivation method: *a la mode Européenne* (European modes of cultivation) and *a la mode indigène* (indigenous modes of cultivation). They are both available only for the year 1904. Despite no clarification as to what the characteristics of each method are, based on the literature on French Algeria, which continuously mentions the indigenous traditional means

labor, and a considerably higher density of indigenous sharecropping – did not introduce modern agricultural techniques and thus relied on traditional means of cultivation. Oued Athmenia (first column), on the other hand, was settled earlier in the late 1860s and had the best land quality for wheat cultivation;[49] yet, as Table 3.5 reports, it displays lower yields in comparison to Aïn Taghrout. Thus, what makes Aïn Taghrout different? Despite its lower land quality, it reports the highest share of cultivated land by European modern methods, the highest density of indigenous rural population and wage labor, and, as shown in Figure 3.8, it is geographically surrounded by the most indigenous-populated areas. Indeed, as shown in the map, it was the nearest to the Kabylia region, the mountainous regions with high indigenous population densities and that was the most intensively affected by land expropriations after the 1870s.[50] Thus, this region had the highest indigenous labor supply and hence the most likely to adopt the more labor-intensive rural techniques. In addition, this closer comparative analysis shows that the municipality with higher suitability (Oued Athmenia), and the one that made a bigger effort to overcome land aridity (Aïn Taghrout), were indeed related to wage-dependent farms.

Table 3.5: Comparative analysis: Oued Athmenia, Aïn Taghrout, and Oum El Bouaghi in 1904/05

	Oued Athmenia	Aïn Taghrout	Oum El Bouaghi
Average year of settlement	1868	1873.5	1897
Average size of large property	426	380	142
Crop suitability	7.38	5.76	5.27
Share cultivated *Á la Mode Européenne*	0.60	0.82	0.05
Settlers			
Wheat cultivated area per settler	14.62	36.58	15.26
Wheat cultivated area per property	159	114	49
Wheat production per cultivated hectares	5.13	5.83	3.31
Share of wine	3.31	0.00	0.00
Share of cereal	0.99	0.99	0.91
Oxen per hectare	0.12	0.00	0.00
French plow per hectare	0.01	0.02	0.02
Mechanical reaper per hectare	0.00	0.01	0.00
Machine per hectare (Tractor)	0.00	0.00	0.00
Rural population per hectare	0.02	0.04	0.06
Rural population per suitable hectare	0.11	0.22	0.16
Indigenous			
Oxen per owned hectares	0.08	0.00	0.00
Sharecropper per cultivated hectares	0.06	0.11	0.23
Laborer per cultivated hectare	0.10	0.20	0.00

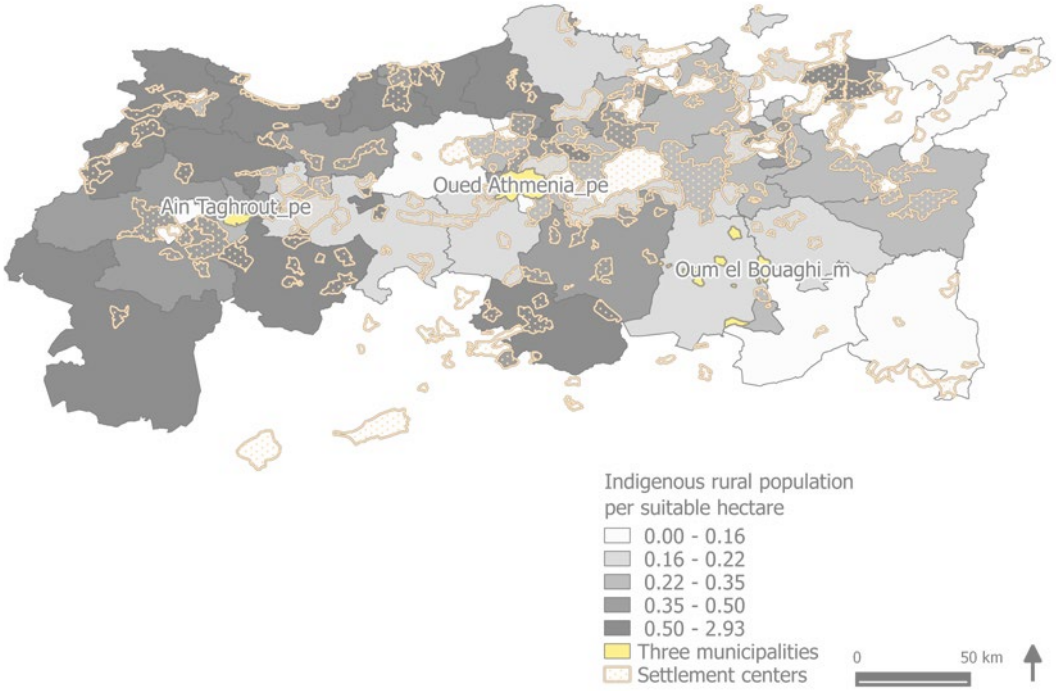
Source: SA (1904/05), IIASA/FAO Global Agro-Ecological Zones Database, Busson (1898), ANOM-iREL. See Appendix D for more detail on sources.

of cultivation as that relying on long fallow and the indigenous plow, it is reasonable to assume that *a la mode Européenne* refers to the modern agricultural practices introduced in the 1900s.

[49] One settlement center was created in 1862, one in 1870, and a third in 1870.

[50] The average elevation index from the IIASA/FAO Global Agro-Ecological Zones Database shows that for Aïn Taghrout it is 973, for Oum el Bouaghi it is 888, and for Oued Athmenia it is 830.

Figure 3.8: Indigenous rural population per suitable hectare, Constantine in 1904/05



The *indigenous rural population per suitable hectare* data is classified according to quantiles (equal count). *Suitable hectare* refers to the number of hectares with a crop suitability for low input level rain-fed wheat above the medium level (that is, equal to 4). *Source*: SA (1904, 1913), IIASA/FAO Global Agro-Ecological Zones Database, Busson (1898), and ANOM-iREL. For details on map sources and spatial aggregation see Appendix D.

But does the previous example of Oum El Bouaghi mean that large properties that relied on indigenous sharecropping – and thus, did not employ waged labor – did not adopt newer agricultural methods? The research by Lützelschwab (2000) on the *Compagnie Genevoise des Colonies Suisses*, a settler farming estate in Constantine, proves the contrary: it shows that the adoption of modern agricultural techniques among indigenous sharecroppers was possible due to the surplus of indigenous labor.[51] According to the author, in the 1890s the land market forces (i.e., expropriations) changed the ratio between land and labor, leading to an excess supply of local labor which ultimately increased the landowners' bargaining power.[52] Thus, it allowed agricultural innovation by increasing the working time and intensity without having to modify explicit clauses in the sharecropping contracts. In line with this argument, as a final check, it is possible to examine the share of land cultivated in the "European mode" by the indigenous population. The share is positively and significantly correlated to the regions affected by the Kabylia rebellion, and a t-test on the mean differences shows strong disparities between the older and the frontier regions. On average, in the old municipalities, the European methods were adopted on almost 50 percent of the total cultivated area, of which 80 percent was cultivated

[51]This example was also presented in Chapter 2.

[52]The author explains that before the land market forces changed (prior to the 1870s), the poverty among indigenous sharecroppers decreased the company's margins to provide the incentives that would increase working time and effort. In addition, land was not exhausted so that the indigenous sharecroppers, if discontent with their contract terms, could search for alternative lands to cultivate.

by Europeans, and 20 percent by the indigenous. In contrast, in the frontier regions, around 30 percent of the land was cultivated *a la mode Européenne*, out of which 60 percent was cultivated by Europeans and 40 percent by indigenous. This demonstrates that the share of land cultivated with modern techniques by the indigenous population was higher in the frontier, particularly if affected by the Kabylia rebellion.[53]

Finally, it is useful to look at the draft-animal regional disparities given that changes adopted in tillage operations across farming systems (i.e., waged labor, sharecropping, or self-sufficient family units) are related to the quantities and prices of animals. More specifically, the climate and soil in the frontier areas required European animal-traction plows for a deeper preparatory plowing during the Autumn season (Lützelschwab, 2000; Trabut and Marès, 1906). In these regions, what previously was left to lay fallow during a period was now cultivated more frequently; thus, it required a higher use of draft animals and needed less land for livestock-feeding.[54] For instance, Trabut and Marès (1906) explain that a colon necessitated one simple or double *Brabant* plow and four to five horses or Arab mules to prepare a 20 hectare plot before the sowing season. Oxen could also be used for the same task (see Figure 3.3) but the final choice of the type of draft animal depended on various factors such as the soil, the climate, the size of plots, access to pasture, etc. Figure 3.9 depicts the mules-to-oxen ratio distribution, reflecting higher values in the frontier regions with worse land quality for cultivation.[55] This seems reasonable as oxen tend to be related to regions with abundant pasture and smaller farms, whereas mules relate to larger farms located in plain fields with scarce pasture (Simpson, 1987, p. 281).

However, these figures must be regarded with caution as the density levels of oxen and mules in Constantine are significantly low. For instance, if we compare the values reported by Simpson (1987) for different regions in Spain at the end of the nineteenth century, one can see that the lowest reported value in 1891 in Spain (for Cáceres) was 1.5 times larger than the highest one found in the department of Constantine, and 20 times larger than its overall mean.[56] These low values in French Algeria are explained by, on the one hand, the lack of association between husbandry and agriculture within the settler sector (Bennoune, 2002) and, on the other hand, the more intensive rural methods that shortened the fallow period and decreased the amount of land available for pasture and eroded the soil (Lützelschwab, 2000).[57] Thus, in the frontier – where

[53]These values come from the SA (1904/05). See Appendix D for more detail.

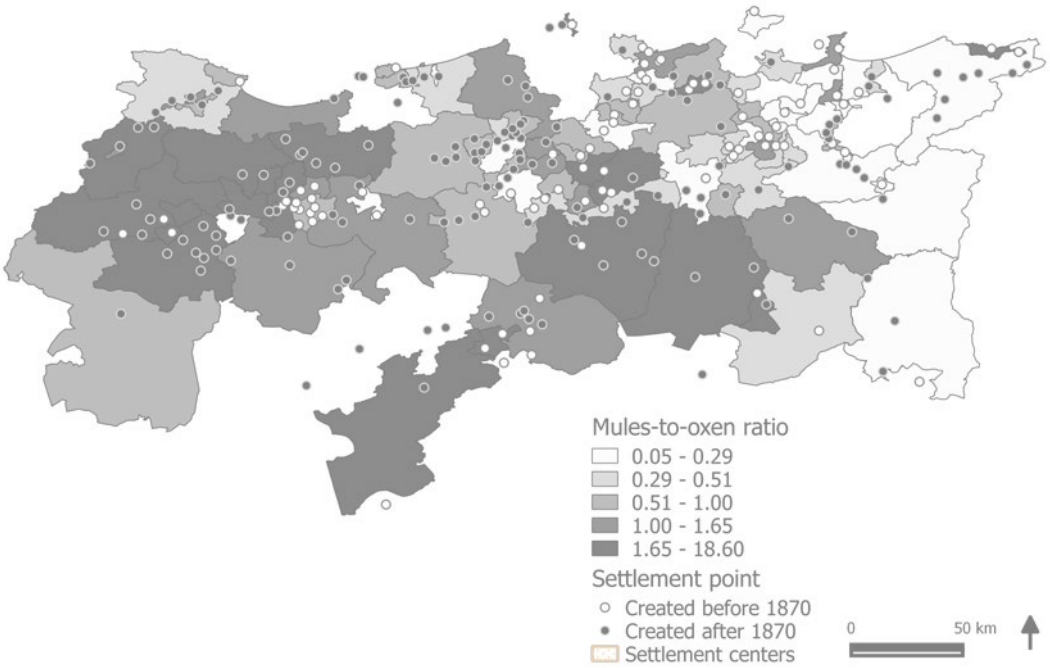
[54]Boserup (1965) explains that to maintain draft animals there are three options: first, keep a part of permanent land for grazing, second, the cultivation period is shortened so that there is a portion of land left fallow for animal pasture, and third, give the animal a portion of the harvest for feeding.

[55]This is supported by: i. the positive and significant correlation between the year of settlement and the ratio, ii. the negative and significant correlation between the density of mules per cultivated hectare and the land suitability index, and iii. the positive and significant correlation between the density of oxen and the land quality.

[56]The author calculates that in 1891 the ratio between the number of mules over the oxen and cows is 34.71 in Sevilla and Córdoba, 27.70 for Cáceres, and 96.69 for Castellón, Tarragona, and Valencia. In Constantine, the highest value for the ratio between the mules and the oxen (not including bulls, oxen for manure, cows, and calfs) is 18.6 in 1904 for Aïn Abessa, but then all the values are below 10 and the overall mean is 1.38. The density of mules per cultivated hectare has a maximum value of 0.5 but the mean is 0.06. The oxen per cultivated hectare have a maximum value of 0.6 but a mean of 0.09.

[57]Livestock among the indigenous population was also negatively affected. The French settlement had an

Figure 3.9: Mules-to-oxen ratio (settler owned), Constantine in 1904/05



The mules-to-oxen data is classified according to quantiles (equal count). *Settlement point* includes towns, villages, settlement centers, hamlets, and individual plots, and is classified according to average year of creation (before or after 1870) of the settlement centers in a municipality. *Source*: SA (1904/05), Busson (1898), ANOM-iREL. For details on map sources and spatial aggregation see Appendix D.

the climate and soil did not favor cultivation, where irrigation and fertilizers were absent, and where land for pasture was too low to allow for mixed-husbandry – the results suggest that settler farmers minimized production costs by hiring relatively cheap labor.

3.5 Conclusions

Because "the great grain or vinegrowing properties absorbed [the small settler's] concessions and spat out the people," Charles-Robert Ageron argued that French Algeria lost its "colonial justification" (Ageron, 1991, p. 61-62). What shaped, then, these properties?

At the turn of the century cereal and wine production grew in French Algeria thanks to colonial trade policy and agricultural structural transformation. Although the limited arable land to expand rural settlement in Algeria was evident by the late 1870s, the average property size per rural settler was high; particularly in the frontier regions settled after the 1870s. This chapter disentangles the relation between the type of farming on large estates, the process of settlement, and the land-to-labor ratio at the outset of the 1900s at a municipal level. To do this it takes advantage of annual agricultural statistics reported by the French administration at the municipal level in Constantine in 1904/05 and 1913/14.

extremely negative effect on livestock density in Algeria (Yacono, 1993). The larger European holdings together with the population growth stirred the indigenous cultivation methods.

The key agricultural change during the colonial years was the adoption of newer and more land and labor-intensive farming methods that permitted to expand cultivation into the more arid frontier regions. The results show that the possibility for the large landholding to innovate and adopt these techniques (i.e., preparatory plowing and the use of the French plow) depended on the availability of indigenous labor. In addition, the generally low levels of advanced agricultural machines (such as the mechanical reaper), particularly in the frontier regions, suggest that large farms relied heavily on the surplus of labor generated by colonial land policies after the 1870s.

Based on the timing of settlement, this chapter first uses Hayami and Ruttan's (1978) Induced Innovation Model to understand the regional differences between wage-dependent estates. This model is an instrument that allows for the assessment of the dynamic process of adoption of agricultural techniques (i.e., the use of mechanical reapers or French plows) by examining the relative amounts of labor and land. The model suggests that the frontier regions, endowed with higher aridity, relied on the abundant indigenous labor supply in order to be competitive. Yet this model only allows for examination of the wage-dependent estates. Thus, to gain a better understanding, the chapter includes a comparative analysis of three municipalities settled in different moments and thus, with distinct soils. It indicates that the municipality with high yields but a medium cultivable soil relates to higher levels of indigenous labor and modern agricultural techniques (not mechanization levels). It finally shows, based on a study by Lützelschwab (2000), that the adoption of modern agricultural techniques in a large sharecropping-dependent estate was possible as a result of a higher labor-to-land ratio after in the 1880s that provided the landowner with a higher bargaining power. Thus, the results suggest that the availability of indigenous labor was the key-factor that allowed the large farms – both wage or sharecropping dependent–in the frontier to be competitive.

The final question is, then, whether these results are consistent with the crowding out of the small rural settlers hypothesis. As shown in this chapter, the frontier regions were significantly endowed with larger properties and lower rural settler density levels. These regions required new agricultural practices to expand cultivation and offset the worse land quality. The institutional land-market regulations after the 1870s – in particular, a decree passed in 1904 that facilitated private land transactions and led to higher land prices (Mollard, 1950)– biased ownership to colons with sufficient resources to face the new cultivation requirements – i.e., purchase of land, buying and feeding draft animals, agricultural instruments, seasonal labor, capital interests, reparations and machinery depreciation, wine cellars, planting disease-resistant vines, refrigerators, etc.– in the relatively less-cultivable regions. In addition, the scarcity of livestock and draft animals, together with the absence of fertilizers and irrigation in the frontier, limited the margins to decrease production costs and, thus, pushed landowners to increase income through rents (Bennoune, 2002). Hence, the need for capital and land prices excluded small settlers from access to the later open-to-settlement lands.

Chapter 4

Build It and They Will Come? Secondary Railways and Population Density in French Algeria

Abstract

This paper examines the effect of gaining railroad access on indigenous and settler population density in French Algeria at the end of the nineteenth century. A growing amount of research shows that railway expansion at this time implied changes within the regional social and production structures, allowing previously marginalized regions to participate in international trade and thereby boosting growth. Yet few studies point out that it also increased marginalization and reinforced dual economies in areas that did not experience access to the infrastructure or that did not have the required economies to profit from and engage in international markets. By taking advantage of unique territorial population data at a sub-municipal level and digitized historical colonization maps in the Constantine region, this paper measures the effect of gaining railway access in relatively isolated areas – areas in which the infrastructure arrived later – using a differences-in-differences methodology. Results show that the indigenous population responded positively to railroad infrastructure only in those regions where settlers were already located while the settler density did not respond to the infrastructure. As a robustness check to the results, this study restricts the sample to minimize selection bias and also provides an instrumental variable approach to account for omitted variable bias. In line with literature on Algerian railways, the results confirm that the railway in Constantine was unfelt in many regions and helped reinforce regional inequalities. The results provide support to the hypothesis that indigenous population growth was partly a response to the colonial demand for labor.

4.1 Introduction

The ratio between the rural settlers and the indigenous population during the colonial years turned out differently from what the French colonial administration had hoped for. At the turn of the twentieth century rural settlers were outpaced by a persistent indigenous population growth. Indeed, as Bennoune (2002, p. 54) explains, it was expected that local population would disappear given that the crisis experienced by the indigenous population between the 1830s and 1870s (i.e., epidemics, droughts, famines, and a major rebellion in the Kabylia region) had allowed many "French theorists" to predict "the doom of the native 'race.'" Yet, after the 1870s, natural growth figures recovered and "alarmed" many settlers. It seemed unreasonable that despite the low indigenous margins to increase agricultural production after the 1870s — i.e., the frontier and cultivable land were exhausted (see Chapter 3), the tribal areas were legally circumscribed, and the tax burden was extremely high — the local indigenous population kept growing and outpaced the growth of settlers. Thus, given that the railway was intended to be an instrument that would ease colonial control and security, and hence expand settlement, it is interesting to see whether or not it helps explain population trends; more specifically, if it helped consolidate settlement by increasing the number of settlers and decreasing the indigenous population density.

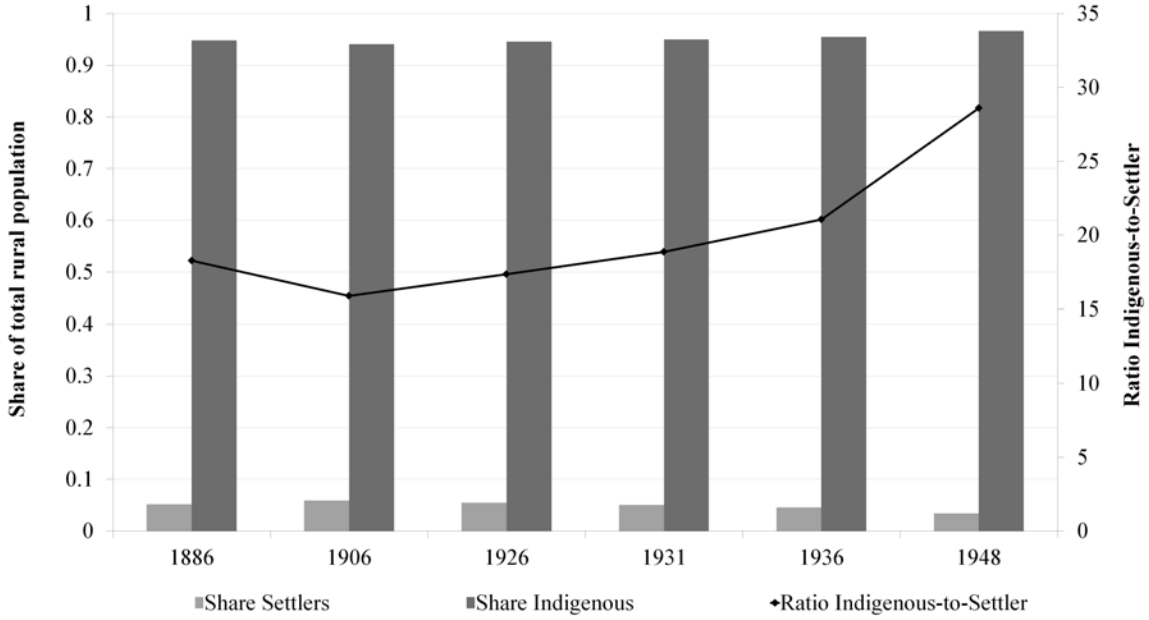
It would seem reasonable to expect that gaining rail access had a clear positive effect on both population groups primarily because, as Nouschi (1961) describes, it allowed for competition in French markets (particularly if waterways were absent) thanks to a higher regional integration and lower transport costs. Yet the true impact is unclear. On the one hand, one could anticipate a positive effect on the settler population given that the "colonization and railways were for the colonists, essential elements in the success of French policies" (Belkacemi, 1984, p. 351), helping to consolidate rural settlement and facilitating market access. However, on the other hand, the effect could be negative or null in some regions as the tariff structure highlighted regional inequalities, favored large producers, and discouraged small cultivators (Belkacemi, 1984; Nouschi, 1961); thus, helping to explain the "crowding out" of the small family farm type of settlement (see Chapter 2).[1]

With regard to the indigenous population, the railway effect in the previous literature is also inconclusive. According to Bennoune (2002), in order to explain its persistent population growth, many historians on colonial Algeria relied on the hypothesis of the removal of the Malthusian positive checks. In other words, they found that colonialism improved living standards and decreased the mortality caused by famines or plagues due to better communications, improved public health services, human capital, etc. Hence, if this were the case, gaining rail access should positively affect population growth. However, following S. H. Coontz,[2] Bennoune (2002, p. 55) argues that the indigenous demographic growth was primarily explained by the colonial demand

[1] Mostly reflected in the relative decline of the rural settler share over the total settler population, which decreased from 41 percent in 1872 to 35 in 1911 (Ruedy, 2005; Ageron, 1968).

[2] H. Coontz, *Population and the Economic Interpretation* (London, Routledge & Kegan Paul, 1957), p. 192.

Figure 4.1: Total rural indigenous and settler population,[3] French Algeria 1872-1936



Sources: Gouvernement Général de l'Algérie (1948). For further detail see Appendix D.

for labor and, therefore, the Malthusian hypothesis had "to be rejected both on theoretical and empirical grounds." This is in line with other authors such as Ruedy (2005), who stated that the labor demand generated by "the concentration of factors of production in colons hands" played the major role given that the persistent indigenous growth, together with higher impoverishment levels, was only feasible if it was accompanied by a growing demand for labor. Then, in this case, the effect of the railway on the indigenous population should only be positive in regions were demand for labor was highest; that is, in the proximities of the settlement centers.

Thus, this chapter measures the effect of gaining railway access on the settler and indigenous population densities. However, as Banerjee et al. (2012, p. 3) argue, the conclusions on the impact of railway's will clearly be conditioned by the selected departure point given that "the first road to connect the agricultural hinterland to a port is very different from the fifth such road." For this reason, I restrict the analysis to the regions in which the infrastructure arrived relatively later in time; that is, during a "second wave" of railway construction in the second half of the 1880s.[4] To do this, it uses a differences-in-differences methodology (henceforth, diff-in-diff). Although the contribution of the railway infrastructure on growth has been studied with very different techniques – depending on the question to be answered, it has been undertaken by means of growth accounting or social savings (Fourie and Herranz-Loncan, 2004; Bogart et al., 2015; Coatsworth, 1979; Fogel, 1979) and economic geography (Fourie and Herranz-Loncan, 2004; Jedwab et al., 2015; Jedwab and Moradi, 2016; Atack et al., 2010; Tang, 2014) – the diff-in-diff permits the analysis of the differential effect on population between the regions that

[3]The settler category is proxied by the non-Muslim group while the indigenous population is proxied by the Muslim category. See Introduction for more detail on terminology.

[4]The "first wave" began with the construction of the first line built in 1862 and the following boom in the 1870s.

gained railway access (treated) and those that did not (control).

To undertake this technique, I will first argue that obtaining access in these remote areas was exogenous to population growth. It is difficult to make such an assumption if economic development, often proxied by population growth, is found to bring in railway infrastructure. Yet the sample analyzed covers areas that obtained access relatively later in time. These areas – some settlement centers and a majority of tribal areas in the municipalities where only a minority of settlers were just starting to locate (*commune mixtes*)[5] – were not a priority for the colonial administration for various reasons: some experienced local resistance during occupation, others were built to extract natural resources, some were necessary to link to Sub-Saharan Africa, and others were created to achieve an equal and fair regional railway distribution. Thus, the construction was partly motivated so as to expand settlement, but not as a response to high population density levels. Additionally, to improve the accuracy of comparison between the treated and the control groups, I match the observations based on a propensity score matching technique and restrict the analyzed samples in different ways (i.e., excluding regions with settlers in 1884 and regions with termini points). I also demonstrate that the regions that received the railway were not relatively more (or less) disadvantaged in terms of population densities and I implement an instrumental variable approach to reinforce the results.

The Impact of Railways on the Economy and Population

Several publications in recent years have documented that the introduction of the railway permitted countries to specialize into higher value crops, reshaping their social and production structures. Market integration grew as hinterland regions, previously marginalized from international trade, were now able to participate, benefit from returns to scale, and many times experience persistent effects on economic development and growth (Jedwab et al., 2015; Jedwab and Moradi, 2016). Among the effects brought in by railroads, Donaldson (2010) argues that the lower trade costs and the gaining of comparative advantage increased the level of real agricultural incomes and decreased the volatility.

In Africa the railroad network is considered to have contributed to the growth of rural populations, modifying the economic activity of the surrounding areas, and triggering urban growth. This new infrastructure led to increasing returns to scale that subsequently consolidated path dependence and set multiple spatial equilibria (Jedwab et al., 2015). According to Yacono (1993), in Algeria, although numerous routes lacked economic sense or strategic location (e.g. connecting settlement centers), overall the network had a significant impact as it reinforced and changed the economic development of the colony. Nouschi (1961) explains that after 1890, when tariffs were relatively more unified and lowered, the railway infrastructure permitted the settler and indigenous products, which were negatively affected by the international grain price drop

[5]Many of these tribal areas were known as *douars* which were areas or sections to which the *Sénatus-Consulte* 1863 had been applied; that is, the areas "legally" divided by the colonial state in order to provide land titles and facilitate land transactions.

in the 1880s and competition from Tunisian wheat,[6] to finally compete in the French market. Additionally, in a detailed study of Algerian railways, Belkacemi (1984) points out that they contributed to urban growth, affected the geographical distribution of settlement, increased both urban and rural populations, and facilitated the implementation of colonial land policy (for instance, to gather information on indigenous land titles the surveyors would locate along the railway lines).[7] It also increased the area cultivated by Europeans (mainly viticulture and cereals) and prompted mining industry (iron ore and phosphates) by means of creating new markets, decreasing transport costs, increasing maritime trade, mobilizing bigger volumes of goods and people, expanding irrigation, and increasing land values in the neighboring regions.[8]

However, in line with Coatsworth (1979), the redistribution of economic activity brought in by the railway could be unequal, lacking backward linkages within a country and exclusively benefiting the export-led sector. This new infrastructure affected the distribution of land and the "balance of social forces," facilitating land grabbing and generating additional labor surplus (Coatsworth, 1979, p. 958). It highlighted dual economies by redistributing economic activity and reinforcing ethnic segregation (Herranz-Loncán et al., 2016). In the case of Algeria, the railway was an instrument through which land policies were consolidated, easing colonial control and the expansion of settlement. Thus, it probably helped channeling indigenous labor surplus into the export-led settler sector,[9] helping set the path towards the dual economy developed during the colonial years.

In addition, tariffs were high and thus the impact on agricultural production was limited. The small farm cultivators, particularly in Constantine, were unable to benefit as they suffered from relatively high tariffs in comparison to large producers (Nouschi, 1961). And even the large farming estates, such as the *Compagnie genevoise des Colonies suisses*, faced prohibitive tariffs and were unable to compete with grain producers in France (Lützelschwab, 2000, p. 190). The high prices for users, the frequent delays, the uncoordinated timetables (because of fragmented railway ownership), the lack of specialized labor, and insufficient rolling stock and station facilities restricted the railroad's effect on agricultural production (Belkacemi, 1984). Finally, the effect in some areas was not significant due to their remote localization and the inadequacy of the line's planned economic viability with respect to cargo flows and population movements (Yacono, 1993). Accordingly, based on Auguste Burdeau's arguments in 1891 in the *Chambre d'Agriculture*, Nouschi (1961) explains that, in contrast to the railway experience in the United States which created economic activity, Algeria lacked the economic life necessary to render the network profitable.

[6] After 1890s the imports of Tunisian wheat were exempt from all taxes in the port of Marseilles.

[7] Belkacemi (1984, p. 334) explains that it was particularly the case for the implementation of the 1873 Warnier Law which established private property among the Arabs; in particular he states that "In 1885, 1886, and 1887, surveyors operated particularly along roads and railways."

[8] Belkacemi (1984, p.343) provides evidence of cases where irrigation was used as an instrument to improve fertility and thus ensure the success of the railway infrastructure by means of increasing traffic.

[9] The export oriented sector, owned entirely by the settler population, relied on the indigenous labor surplus generated by colonial land policies (Griffin, 1976).

Therefore it seems reasonable to suggest that the railway's contribution to the development of Algeria's dual economy was manifold: it facilitated growth exclusively for large producers as it improved access to relatively cheap indigenous waged labor, discouraged small family producers with high tariffs, and highlighted regional differences by providing comparative advantage to the regions that gained access or that were endowed with relatively competitive tariffs. Given that, already prior to independence, the country lacked export diversification and was characterized by high income and social inequality,[10] and that "the dominant characteristic of the Algerian market was its fragmentation" (Ruedy, 2005, p. 96), it is interesting to examine whether the railway played a relevant role in this, fitting within the literature linking colonialism and long-term economic growth (Acemoglu et al., 2001; Dell, 2010; Allen et al., 2012; Frankema, 2011).

This chapter also adds on research that studies the effect of the railroad on population. The population density is frequently used as a proxy for economic development and growth (Atack et al., 2010; Hornung, 2013; Jedwab and Moradi, 2016; Gregory and Henneberg, 2010; Berger and Enflo, 2015), and most studies tend to find that it responds positively to the arrival of the railway. For instance, Hornung (2013) argues that the railway positively affected Prussia's urban population growth between 1840 and 1871. Gregory and Henneberg (2010) conclude that earlier access leads to a higher population growth in England and Wales between 1825 and 1911. Atack et al. (2010), while trying to clarify the bi-directional causality between settlement and economic development in the American Midwest, find that although the effect on population densities was insignificant, the impact on the share of population living in urban areas was positive and significant. Likewise, Berger and Enflo (2015) demonstrate that population growth in towns was positively and significantly affected by the arrival of the railway during a "first wave" of railway expansion in Sweden between 1855 and 1870, yet much of it was explained by the redistribution of economic activity. Finally, Jedwab and Moradi (2016) show that although the railway in Sub-Saharan Africa was exclusively built to link the coast to the mining centers, the lower trade costs pushed the nearby rural populations to engage in cocoa production, augmenting rural populations (as labor demand increased) in the railway's proximity, raising population in the urban centers (as trading stations developed), and ultimately affecting the distribution of economic activity. Hence, following this literature, it is also to be expected that the railway positively affected overall population density levels.

[10] As shown by Good (1961), by 1954 the non-Muslim population was fully within the "developed" sector and a 10 percent was located in the rural sector and the rest in non-agricultural activities, whereas Muslims were mainly located in the agricultural sector (around 70 percent of the total) with about 80 percent of them engaged in the traditional sector. The source used by Good (1961) is the *Tableaux de l'Economie Algérienne*, 1958, p. 24 from the *Service Statistique Générale*. Additionally, there were only a few Algerian landowners that were able to diversify into a market economy, but the amount was insignificant relative to the total rural indigenous population (Ageron, 1991; Stuart, 2010).

4.2 The Railroad in French Algeria

The Geographical Railway Network[11]

On the African continent the railroad network expanded from almost 1,750 route kilometers in 1871 to nearly 6,600 in 1884. Most of it, about 40 percent, belonged to the British in South Africa, but almost 30 percent was built in Algeria (Harter, 2005). By 1935 the Algerian network was comprised of a total of 4,861 kilometers (*Direction des Chemins de Fer*, 1935).[12] Over half of the French colonial expenses were directed to Algeria and distributed between military expenditure and the payment of the railroad interest stock (*Guarantie d'intérêt*) (Bobrie, 1976). According to Belkacemi (1984), total Algerian colonial investment in the railway infrastructure amounted to 633 million francs, without including the 367 million interest stock paid to shareholders.

It was under Napoleon III that railway construction began in the colony, and the basic overall structure was completed in the 1890s. It was formed by a main trunk route running parallel to the coast linking Oran, Alger, and Constantine to other coastal and interior regions.[13] The Constantine railway network, as shown in Figure 4.2, united the ports of Bougie, Philippeville and Bône and the southern hinterland regions Tébessa, Aïn-Beïda, and Biskra to the central line. By the end of the 1880s Algeria's rail system linked Morocco to Tunisia and crossed important inner cities.[14]

The *Compagnie des Chemins de Fer Algériens* (CCFA) was the first company to obtain line concessions in 1860 for the Philippeville–Constantine, Algiers–Blida, and Oran–Sig routes. It was a joint-stock company created to consolidate French presence and allow the transport of natural resources from the hinterland regions to the ports. In 1862 the company inaugurated eight steam locomotives which carried both passengers and merchandise at a speed of 20 to 25 kilometers per hour between Alger and Blida. Nonetheless, only the Algiers–Blida line was completed as financial problems soon affected the company which, according to Belkacemi (1984), were explained by a lack of administrative efficiency and insufficient geographical studies of relief and climate. Consequently the government had to rely on alternative companies and by the late 1880s the six railway lines built in Algeria were owned by the East Algerian Company (CEA), the Franco-Algerian Company, the Parys-Lyon, the Mediterranean Company, the Bône-Guelma Company (CBG), the West Algerian Company, and Mokta-el Hadid (Harter, 2005).

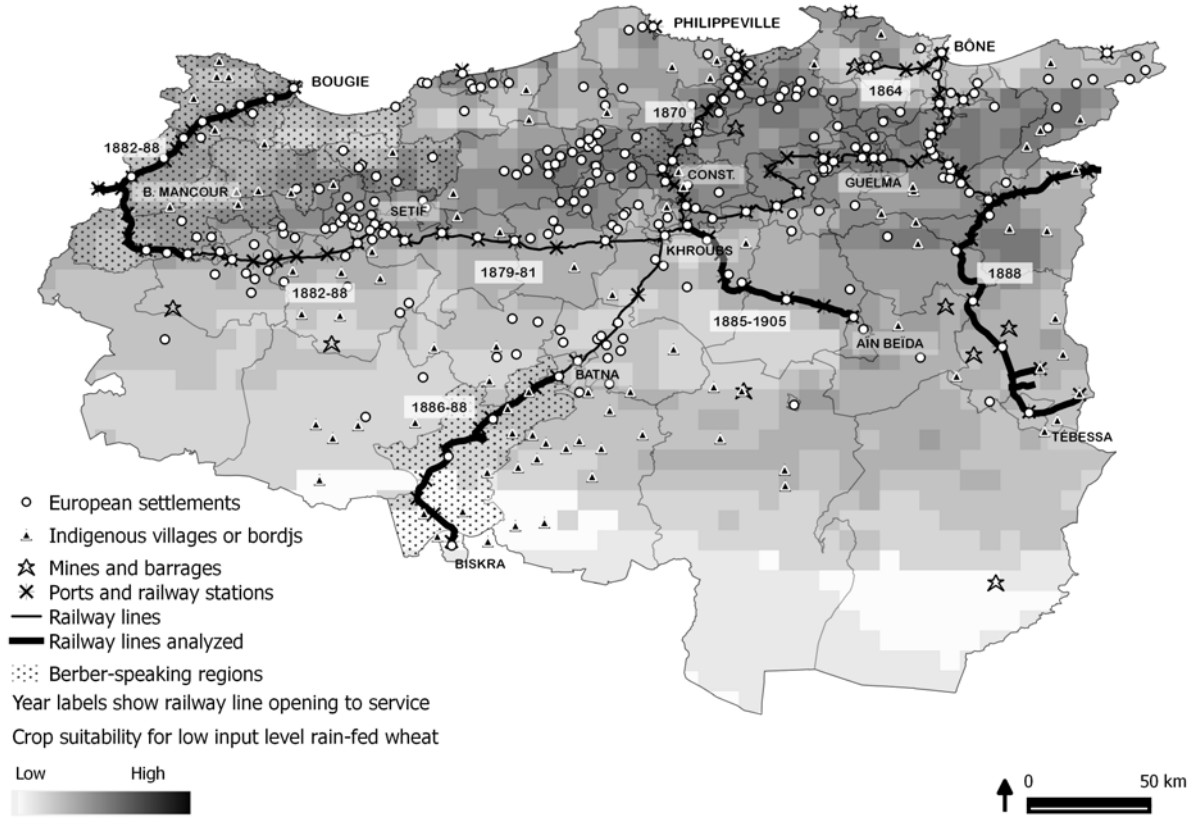
[11] Most information on the geographic distribution and expansion of the railway in French Algeria has been obtained from the webpage http://alger-roi.fr/Alger/transports/chemin_fer/, containing many articles and historic material on Algeria's railway's network. In particular, I have relied on Morton (2000) and Pastor (2001).

[12] The published statistics from the *Direction des Chemins de fer* also reports that the network had a total of 809 steam locomotives and 32 electric locomotives. There were a total of 932 traveler wagons, including 13 luxury cars, 4 restaurants, and a total of 40,985 seats. In order of volume the products most transported were cereal, *farines*, wine, *vinagrettes*, beverages, minerals and livestock.

[13] The latter, together with its coastal vertebrates, was established by the first of the three development plans designed to create the infrastructure. The first was established in 1857, the second plan began in 1879, and the third initiated in 1907 and lasted up to 1909.

[14] It was expected to link Senegal and Gaboon-Congo through the Sahara desert but this was never achieved.

Figure 4.2: Map of Constantine in the 1900s



Source: CEPC (1883) and CVC (1902). The regions are dotted if the density of the Kabylia or Berber speaking population (owners) over the total number of hectares owned by the indigenous population is above one. For more detail on source see Appendix D

All Eastern line concessions were distributed between the CEA and the CBG. Although the CEA opened the Philippeville–Constantine and Constantine–Sétif lines before the 1880s,[15] it is during this decade that the company finally finished the Eastern network. The Ménerville–Sétif line was completed with the inauguration of the El-Achir–Sétif section in 1882 and the El-Achir–Ménerville in 1886. The Bougie–Sétif line was completed with Bougie–Beni-Mançour in 1888 and Tazmalt–Beni-Mançour in 1889.[16] The company expanded into the south by building the track el-Guerrah–Biskra in different sections: Batna–Aïn-Touta in 1886, Aïn-Touta–El-Kantara in 1887, and El-Kantara–Biskra in 1888.[17] It then inaugurated Aïn-Beida–Ouled-Rahmoun in 1889 and later, in the 1900s, expanded to Khenchela.[18] The rest of the Constantine network was assigned to the CBG,[19] launching the Bône–Guelma and Guelma–Khroubs routes

[15]The Philippeville–Constantine line opened to traffic in 1870 and the Constantine–Sétif concession was in 1875 and opened to service in 1879. The CEA was also assigned other tracks between Alger and Constantine, such as Maison–Carrée-Alma in 1877 (in circulation 1879) and Alma–Ménerville in 1878 (in circulation 1881).

[16]Both conceded in 1884.

[17]The concession for all these lines was granted in 1880.

[18]The first line is conceded in 1885 while the second in 1900. The prolongation after the 1900s to Khenchela is not included in this study.

[19]Also named the *Société de Construction des Batignolles* to which the initial concession was granted in 1874 and who also received the concession for the line from Tunisia to the Algerian border in the late 1870s.

before the 1880s.[20] It then opened Souk-Ahrás–Duvivier in 1881[21] and spread to the Tunisian border in 1884.[22] Ultimately, the Souk-Ahras–Tébessa track was completed in 1888.[23]

Build It and They Will Come?[24]

The methodology measuring the effect of the railway requires clarifying that the reasons behind the expansion of the infrastructure were exogenous to population growth. This section, mostly based on Belkacemi's (1984) thesis *French Railways in Algeria, 1805-1990*, argues that the lines built in the 1880s (see the darker lines in Figure 4.2) were established in order to increase settlement, for strategic purposes (i.e., mainly to consolidate settlement), and as a matter of regional equality, and therefore they did not relate to the already existent population levels.

Railway expansion was primarily a tool used by the colonial administration to advance settlement. Belkacemi (1984, p. 322-323) quotes the following report from Burdeau's House of Representatives:

> Draw a map of Algerian railways and another of the density of European population [...] and you will notice that the railway is a perfect colonizing river which carries new settlers and sets them down along its banks.[25]

According to the author, this was particularly the case during the 1880s in the new open-to-settlement territories, such as the settlements built between 1881 and 1891 in the High Plains of Sétif, Batna, and the lands around the Beni-Mançour–Bougie tracks (Belkacemi, 1984, p. 323). In these regions, which are the ones included in the analysis, the settlers came after the line and/or were settled in the proximities of a projected line.[26]

There was also a strong military component that explained the construction of the railway lines in the regions analyzed. For instance, Belkacemi (p. 321) notes the following statement from the *Courrier d'Oran* in 1881:

> [France] should construct railways in the territories of hostile (or suspect) tribes and make the stations military strong point and fortified blockhouses from which to carry out surveillance and control of the surrounding areas.[27]

[20] Within the line Bône–Guelma, the track Bône–Duvivier opened to transit in 1876 while Duvivier–Guelma opened in 1877. The concession was given in 1877. Khroubs was linked to Constantine by the completion of the Constantine–Sétif track.

[21] Conceded to the company in 1877.

[22] It was conceded in 1882 and the line opened to service the 29th of September 1884. Yet the population data used in this paper from the TGdC in 1884 dates on the 30th of September, so the probability that the population data is affected by the railway opening is very low.

[23] Declared of public utility in order to be built in 1885.

[24] The quote in the title is commonly attributed to the movie Field of Dreams (1989). In the movie the quote is "If you build it, he will come."

[25] Burdeau, A. *L'Algérie en 1891. Rapport de discours à la chambre des députés*, Paris, 1892.

[26] Furthermore, the author argues that the decrease in the creation of colonial villages was explained by the lack of railway development after 1892.

[27] From Courrier d'Oran, 19 October 1881.

Indeed, most of the tracks analyzed in this chapter (i.e., El-Guerra–Batna, Batna–Biskra, Ouled-Rahmoun–Aïn Beïda, and Duvivier–Souk-Ahrás–Tébéssa) "were all conceived as *lignes de pénétration* of only mediocre economic value" and were designed to restrict uprisings and secure the territory (Belkacemi, 1984, p. 318). In addition, the dotted areas in Figure 4.2 account for the Kabylia or the southern Aurés and Oases (in the proximities of Batna and Biskra) which were to be secured as they experienced more indigenous uprisings (in particular, after the 1871 Kabylia rebellion).[28] The map illustrates how the lines connecting Bougie, Constantine, and Philippeville formed a "defensive outer circle" that would surround the most rebellious regions (Belkacemi, 1984, p. 315). Even the lines linking Tunisia and going south towards Tébessa were built as a response to the needs of the ministry of war who aimed to secure the Tunisian border, facilitate occupation, and transport troops directly from Bône (Belkacemi, 1984).

Finally, the factors explaining railway expansion in Constantine were often based on matters of fairness rather than economic ones. Indeed, regional inequality with regards to railway expansion – in contrast to the road infrastructure, which was homogeneous throughout the departments – often became the primary cause of conflict, leading to the formation of pressure groups in the *Conseils Généraux* or in the Chambers of Commerce. For instance, traffic to the port of Bougie severely diminished given that most of the products transported from the plateau of Sétif went to the ports of Alger and Philippeville.[29] According to Belkacemi (1984), the cause of its lagging behind in trade was the delay in the construction of Bougie's railway, which also became a motive for conflict. The author explains that El Guerrah–Batna, Batna–Biskra, Souk-Ahrás–Tebessa, and Beni-Mançour–Bougie lines proved to be economically inefficient as they were built based on equity issues.

The Effects of the Railway Network

The effect of the railway on Algeria's economic activity and population growth is unclear. On the one hand, economic historians have proven how railway infrastructure increased rural settlement, contributing both to the growth of population and the creation of settlement centers. It provided greater security and helped promote the development of towns by attracting merchants, leading to the establishment of new shops, hotels, etc. (Belkacemi, 1984). Yet, on the other hand, historians have also argued that the effect was null and that railway expansion highlighted regional inequalities. As Nouschi (1961) explains, the colony lacked sufficient economic life to render the network profitable.[30] The insignificance of the railways' impact in some areas was often due to their remoteness and the inadequacy of the line's planned economic viability with respect to trade flows and population movements (Yacono, 1993). This seems to be particularly the case

[28]The dotted area in Figure 4.2 displays the regions endowed with the highest densities of Kabylie or Berber-speaking local populations. The data was obtained from the SA(1904/05). See Appendix D for more detail on sources.

[29]The three of them were initially built during French occupation for military purposes. The ports of tertiary importance in Constantine were Djidjelli, Collo, Herbillon and La Calle.

[30]The author quotes Auguste Burdeau in the *Chambre d'Agriculture* in 1891.

for the Constantine department and, more specifically, for the regions that gained access during a "second wave" of railway expansion in the 1880s. In fact, the evidence suggests that the effect of these railway lines –specifically, El-Guerrah–Batna, Batna–Biskra, Souk-Ahrás–Tébessa, and Beni-Mançour–Bougie– was essentially null (Belkacemi, 1984).

The railway's limited impact on economic activity is explained by the high tariffs and their complex structure. Belkacemi (1984), based on numerous reports from the Chambers of Commerce and the *Conseils Généraux*, explains that the tariff structure, in particular that regarding special tariffs, resulted complex and unclear to users who frequently manifested their discontent. The tariffs were high and differed across regions; for instance, in 1886 the cost of transporting cereal in Constantine was 8 cents per ton higher as compared to Oran and Alger. Similarly, the tariffs in Algeria were higher than those set in France and, despite certain reductions before 1892, the gap between both territories remained significant (ranging from 25 percent to 50 percent). Additionally, the administrative process required to modify tariffs was complicated and the incentives were low.[31] Indeed, there was a general consensus, reflected in the 1877 and 1884 parliamentary reports, in the Chambers of Commerce, and the *Conseils Généraux*, that the tariff reductions in Algeria did "not really stimulate commercial transactions" (p. 282).[32]

One of the reasons explaining the high and regionally unequal tariffs was the lack of route competition between the railway companies due to their geographical isolation and sharing of the long-distance lines. The only competition encountered was that based on redirecting the commercial flows to the ports by means of special tariffs. In Constantine, as Belkacemi (1984, p. 285) explains, the competition between the CEA, the PLM, and the CBG with regards to certain commodity flows generated "complaints from disadvantaged regions that the benefits of reduced tariffs ought to be generalized throughout the colony." Furthermore, the introduction of differential tariffs in the late 1880s – that "reduced the value of proximity," benefiting intra-termini, long-distance routes, at the expense of the regions relatively near the ports – provided some producers with an "unfair advantage" while others were negatively affected, especially in the marginal regions (Belkacemi, 1984, p. 283):

> They [the railway companies] were [...] reluctant to extend the benefits of differential tariffs to undynamic economic regions where traffic was limited and operating costs high. The ability of the railway companies to engage in seemingly arbitrary tariff policies was constantly blamed on their monopoly position and the advantages offered by the *guarantie d'intêret* system.

[31] The proposals had to pass through the *Gouvernor Général* and several colonial bodies, the *comité consultatif*, and the minister of public works. Tariff reductions were particularly difficult to approve as they ultimately implied a lower income for companies and thus, an increase in the *guarantée d'intêret* paid by the State to finance the railway (Belkacemi, 1984).

[32] Belkacemi (1984) relies mainly on the *Conseil Général d'Alger*, Oct. 1899; *Chambre des députés*, 1893; *Chambre de commerce de Bone*, 1883-84; and *Chambre de commerce d'Alger*, 1876-77. For more detail on sources used by the author see (Belkacemi, 1984, p.280-283).

Even in times when agricultural production was high the effects of the railway were restricted. The high seasonality of crops, notably in Constantine where cereal cultivation was important, often provoked shortage crises during high production seasons due to the lack of storage space in station facilities,[33] scarcity of specialized labor, and insufficient rolling stock. Furthermore, crop seasonality complicated the ability of railway companies to calculate the optimal crop volume to be transported. This led to an excess of transport capacity throughout the year that increased expenses, which pushed the companies to lower operating costs, thereby decreasing capital investment and efficiency (i.e., reduced maintenance, infrequent service, high tariffs).

However, the reduction in operating costs was mostly determined by the type of colonial railway financing system. To attract private capital, after 1874 the State relied on a *forfait* (or fixed rate) state guarantee (*guarantie d'intêret*) system, granting concessions to companies in exchange for an annual fixed payment.[34] The payment lasted the whole concession term of 99 years and was proportional to the initial capital invested. Thus, the company's gains did not vary with its actual yearly expenses so that the incentives were directed to gain profits by decreasing construction and exploitation costs.[35] According to Belkacemi (1984), this system required an excessive share of the colonial budget (increasing from 10 percent between 1872 and 1878 up to more than 26 percent after 1888), but it also pushed concessionaries to minimize costs, ultimately benefiting shareholders and neglecting the economic development of the colony. Therefore, in addition to the lack of specialized material, such as refrigerated wagons (Nouschi, 1961), the cuts in operating costs ultimately led to frequent delays and excessive transport time for the commodities (Belkacemi, 1984).

It is also argued that the railway solely benefited large-scale producers (mainly wine and cereal) and harmed the small, rural ones. Nouschi (1961, p. 603) explains that the latter were particularly concerned with the high tariffs. For instance, the tariff by rail between Alger and Constantine was 27 francs, while one paid by sea through Philippeville was 14.80 francs (out of which 60 percent of the cost was getting from Constantine to Philippeville by rail). In Constantine, a small cultivator paid 8.60 francs per ton at a low speed and 19.50 francs per ton at a fast speed, while large producers benefited from fixed price tariffs for volumes from eight to ten tonnes, paying 3.70 francs per tonne and 3.37, respectively. In addition, there was no product differentiation so that using the railway was relatively more expensive for the small cultivator engaged in cheap products such as barley or wheat. It is also argued that tariffs were too high for large producers. As an example, (Lützelschwab, 2000, p. 190) describes the case of the *Compagnie genevoise des Colonies suisses*, a farming enterprise dedicated to cereal in the High Plains of Sétif. The company was negatively affected by the delay of the arrival of

[33] Belkacemi (1984, p. 291) based on the annual reports of *ponts et chaussées* engineers, argues that these "criticized the short-comings of goods depots in terms of insufficient area covered by platforms and marshalling yards, the shortages of equipment such as small cranes and of personnel."

[34] Before the State had also provided subsidies for construction.

[35] There were some exceptions to this (for example, for the CEA) as in some cases the State did take into consideration annual expenses, yet there was a minimum limit set above which it ceased financing exploitation costs.

the railway (after the 1870s);[36] yet, once the railway arrived, the tariffs were relatively high and restrained competition with foreign grains. Small producers were also discouraged by the enhanced land values; the expansion of the railway pushed land prices upwards as European speculators demanded more land concessions around the projected areas for the construction of the railway. The value of a piece of land crossed by a line could vary significantly due to its proximity to urban areas or the soil quality. For instance, the CEA paid on average 700 francs per hectare between El-Guerrah–Batna, 310 between Batna and Biskra, and 1,320 for the tracks between Bougie–Beni-Mançour (Belkacemi, 1984).

4.3 Data and Empirical Model

I study the impact of the railway on population densities using a propensity score method in a diff-in-diff model between two time intervals: 1884-1892 and 1884-1897. The purpose of this methodology is to look at the differences in the outcome variables between a treatment group, formed by areas that gained railway access, and a control group, represented by the ones which never gained access. The propensity score method allows reducing the potential bias caused by covariates that could also determine the probability of gaining railway access.

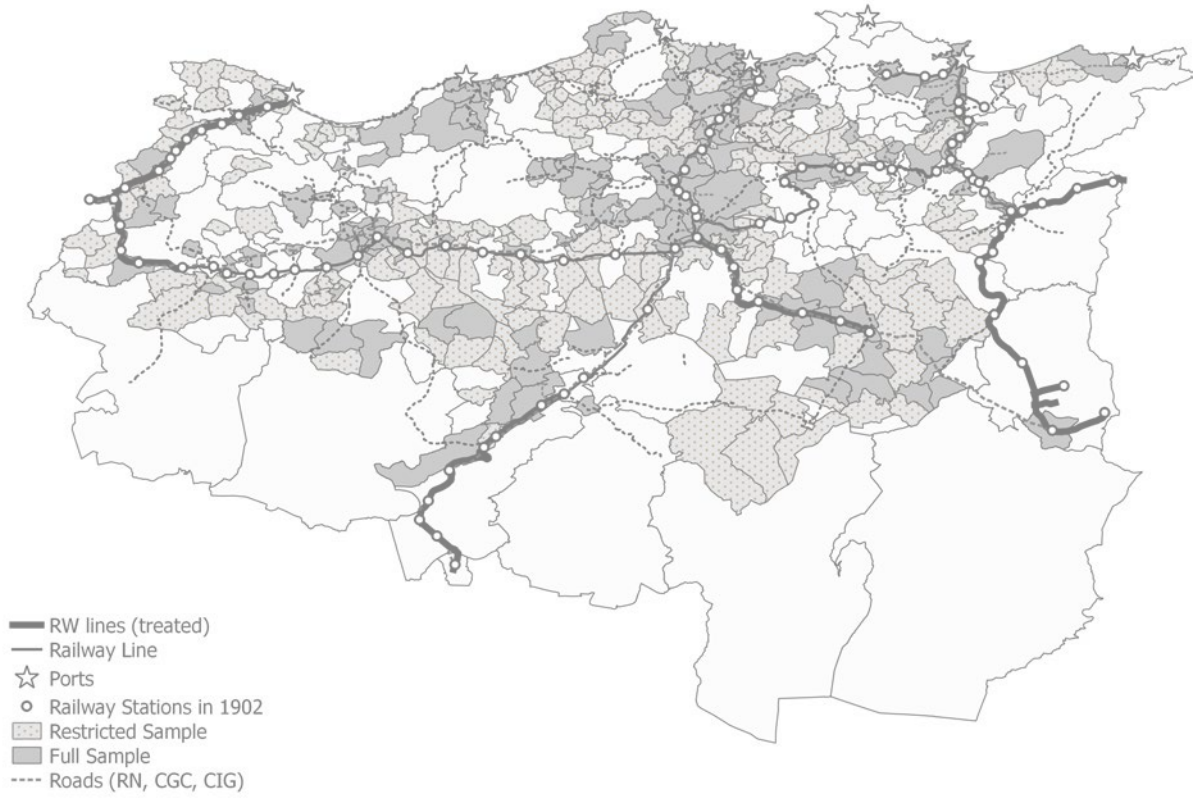
Data Description

Although a significant number of lines were built in the 1870s, the darker lines in figure 4.3 show the sections that opened to service between 1884 and 1892. The regions affected by the darker lines are the ones analyzed in this study, allowing the examination of the impact of the railways on the population density for the years 1892 and 1897. The units of observation, which I will refer to as "areas" or "regions," are mainly settlement centers and *douars* whose population data is available for the relevant years and that did not experience any territorial changes between 1884 and 1897. The dependent variable is the population density per hectare, accounting separately for the settler and the indigenous populations. This is in line with numerous authors that, in order to measure the effect of the railway infrastructure, use the population density or urbanization levels as a proxy for economic development and growth (Atack et al., 2010; Hornung, 2013; Jedwab and Moradi, 2016; Gregory and Henneberg, 2010; Berger and Enflo, 2015). The treated variable accounts for the distance to the nearest railway station: it takes the value of 1 if the distance between the region's centroid and the nearest railway station is lower than 20 km (*D_<20km*) and 10 km (*D_<10km*) progressively, and 0 in the opposite case.

The years being analyzed coincide with the population data available in the TGdC (*Tableau Général ... des Communes*) for the relevant years (see Appendix D for details). These statistics were published by the General Government of Algeria (GGA). They provide information on

[36]The lack of communication infrastructure forced the company to rely on intermediaries/traders to trade its products. Thus, when cereal yields were scarce, the barley was sold to the Kabylia populations and the rest to the Saharan populations in the Southern regions.

Figure 4.3: Selected regional sample: full and restricted, Constantine between 1884 and 1897



Source: CEPC (1883), CVC (1902), and CCO (1902). See Appendix D for more detail on sources.

population densities and cover both the civil and military territory.[37] The General Governor was in charge of providing yearly statistical information to the French Parliament on the colony's progress. He also indicated how the prefects in Algeria should adapt to the French data-collection system (Kateb, 2004). However, Algeria was very different, in particular with regards to the presence of nomadic populations.[38] Thus, the applied census technique changed according to the surveyed population category; namely, the populations in the civil territory and the ones located in the settlement centers in the military territory completed a family questionnaire, while the populations in the tribal areas within the military territory were inferred by counting the number of tents (assuming that each tent hosted five to seven people). Hence, this study is limited to the civil territory, and thus the results are less affected by the differences in the data-collection methodology.

The data has a unique spatial detail that goes beyond the municipalities and is subdivided

[37]The 1884 volume reflects the state of the population situation on the 30th of September while the 1892 and 1897 volumes refer to the 1st of January.

[38]Griffin (1976) explains that in Algeria, in addition to the sedentary indigenous rural owner or *fellah*, there were the semi-nomads and nomads. Among the semi-nomads, some moved continuously from one area to the next depending on the pasture, while others changed from a summer camp to a winter camp. Yet these groups did not move from their tribal area and thus, should not affect my analysis, as my unit of observation is the tribal unit. The nomads, however, did leave their tribal areas: in the spring they moved from the southern regions in the Sahara to the north and returned in October.

into settlement centers (*centres*), plots of land (*fermes*), tribal areas or fractions, and *douars* (i.e., the tribal areas to which the *sénatus-consulte* had been applied). Given that the previous chapters have focused on municipalities, it is interesting to study a different unit of observation. Indeed, the territorial division in French Algeria reflected very diverse regions regarding both the administrative organization and the population structure. As previously explained, the territory was divided into three departments that were then subdivided into municipalities or *communes* (i.e., *communes de plein exercice* (CPE), *communes mixtes* (CM), and *communes indigènes* (CI)). This study exclusively covers the CPE and CM as these were the ones controlled by France in the Northern part of Algeria during the years analyzed. The majority of settlers located in the CPE, which were the municipalities under French rule and where the colonial administration was elected. In the CM, on the other hand, the majority of the population was indigenous; these were the municipalities where the colonial *Administrateur* was chosen by the general government and were governed under Islamic law. The latter, which were projected to be future CPE, were mainly tribal areas and *douars*, included military posts, and were regions with none (or very few) settlers; only a few of them were beginning to engage in commercial or industrial activities.

It is within the type of data used that I can encounter two types of selection bias that affect the diff-in-diff approach. On the one hand, the composition of each group might change throughout the analyzed period; yet this is not a problem since all the regions included in the analysis cover the same territorial areas between 1884 and 1897.[39] On the other hand, the selected groups might differ significantly between them leading to biased results. In other words, regions that experienced railway access might differ from the ones that did not in ways that can differently affect their trends in time without being uniquely explained by gaining the railway. Empirically, this selection bias would require the assumption that the railroad arrival was a random event so that, in absence of the treatment, both treated and control groups would have followed the same trends in time. Although this assumption is not directly testable, it is possible to provide robustness checks to the results by undertaking an instrumental variable approach or using pre-treatment data to test for the parallel trend assumption (Atack and Margo, 2011; Atack et al., 2010). However, given the limited data available, it is not possible to implement the pre-treatment test. For this reason I first argue that gaining railway access was exogenous to population growth, I then demonstrate that the regions that received the railway were not relatively more or less disadvantaged in terms of population densities, I restrict the sample in various ways to compare regions which should behave equally, control for termini points, apply a propensity score matching technique, and I finally use an instrumental variable approach to reinforce the results.

The sample selection leads to a bias which helps support the exogeneity assumption. The

[39]The results might be slightly affected by the displacement of the nomad population given that the 1884 TGdC reports the population on September 30th and the 1892 and 1897 provide the information for the 1st of January. However, I rely on the assumption that the nomadic population was not reported throughout the analyzed years. Indeed, based on the research from Kateb (2004), the registration of civil status in the Sahara did not begin until 1901 and the nomads escaped registration.

reasoning is the following:

First, matching the data between 1884 and 1897 requires omitting the areas that experienced boundary changes throughout the period. Hence, the sample selection was biased towards non-attractive regions for settlement. This is because the attractive ones were continuously being occupied and expanded, having the highest probability of experiencing territorial modifications and, therefore, of not being included in the sample. This allows one to infer that population pressure in these areas would not be a major force explaining the construction of the railway. Indeed, within all the regions matched for both 1884 and 1897 for all Constantine, only 30 percent had at least one settlement point (i.e., towns, villages, settlement centers, villes, hamlets, and individual plots), suggesting that the regions that could potentially affect the probability of gaining rail access were only a low share.[40]

Second, the treatment sample is limited to areas that experienced railway access "relatively" later in time during the colonial years. As explained in the previous section, the first railway line was built in 1862 by CCFA and the rest was mostly constructed in the 1870s. The areas of track taken into consideration in this analysis are Batna–Biskra, Souk-Ahrás–Duvivier, Souk-Ahrás to Tunisia, Ouled-Rahmoun–Aïn Beïda, El Achir–Beni-Mançour, and Beni-Mançour–Bougie. The *Dictionnaire des Communes* (DdC) in 1878, together with secondary literature, provide insights as to why the railway would go to these termini points. Aïn Beïda was endowed with mineral natural resources (such as silver, lead, antimony, iron, and natural salt resources) and extensive forests. The El-Guerrah–Batna, Batna–Biskra, Ouhled-Rahmoun–Aïn-Beïda lines were "*lignes de pénétration* of only mediocre economic value" but were of strategical military interest (see prior section). The first two "penetrated the heart of the two most rebellious regions in the colony" and the Souk-Ahrás–Tébessa line was to "secure the border to Tunisia" (Belkacemi, 1984, p.318). Souk-Ahrás was basically located on the line projected to the Tunisian border. Additionally, Belkacemi (1984) explains that the line concessions of Batna–Biskra, Souk-Ahrás–Tébessa, and Beni-Mançour–Bougie were built as a response to equality considerations, namely achieving the same infrastructure distribution throughout Algeria, rather than economic motives. For instance, the construction of the Bougie and Beni-Mançour track, which was continuously delayed due to indigenous resistance in the Kabylia, was finally completed as a response to the pressure groups demanding equal terms. Hence, this example also supports the argument that the colonial administration did not grant these concessions based on population density levels.

One might additionally argue that even though the reasons explaining the creation of the posterior lines were exogenous to the settlement of population, it seems reasonable that the railway companies in charge of building the infrastructure, by means of governments concessions, ultimately obeyed the colonial administration's goal of increasing and consolidating settlement. Additionally, it is logical to suggest that it is within a company's economic interest to run through populated regions and increase traffic. Yet, as Belkacemi (1984) argues, although both the companies and the administration shared the same interest, the former did not respond or

[40] From a total of 336 areas only 101 had a settlement point.

subordinate to the administration's demands. As stated by Belkacemi (1984, p. 340-341), not only did the "state did not have a free hand policy on colonial questions related to the railways" over the companies, but it was the companies who many times influenced and pressured the administration's decisions on the location of settlement centers. In addition, as argued in the prior section, the tariff structure set in Algeria did not provide incentives (in particular in the remote areas) to increase the commercial value of railways, pushing the companies to increase income by reducing costs (Belkacemi, 1984). Thus, although the first lines were built based on economic and population considerations, the ones included in the sample were not dependent on population – particularly as they passed through more rebellious regions– and even though the colonial administration expected to expand settlement and secure those areas, the companies did not respond to the administration's demands.

In order to further overcome the potential bias because of the exogeneity assumption – i.e. the railway was constructed in regions with a higher potential for population growth – I divide the observations into a "full" and a "restricted" sample (see Figure 4.3). The full sample includes all the observations with available data for 1884, 1892, and 1897, and with no boundary changes throughout those years. The restricted sample includes only the regions that had few or no settlers in 1884. By looking at the DdC in 1884 it is possible to see that the regions which were "developed" from a settlement point of view (with a colonial school or church) in the full sample were endowed with at least 50 settlers,[41] and the regions with less that 30 settlers were mostly used as caravan areas or remote military posts. Hence, I limit the restricted sample to areas with less than 30 settlers in 1884.[42] About 90 percent of these regions are *douars* and tribal areas that were highly restricted to settlement, reinforcing the conclusion that the impact of the railway in the latter was not induced by European presence or planned colonization centers. Moreover, given that these regions do not appear to be colonization centers in the 1902 official colonization map (COC), it is reasonable to assume that they were not projected settlements in 1884. Based on the box plot in Figure C.4, I provide an additional test by limiting both the full and restricted sample to the regions with the indigenous population density value below 2 in order to exclude extreme outside values in the control group and increase comparability.

It is also necessary to test whether if, prior to the arrival of the railway, the regions that gained access were relatively more advantaged (or disadvantaged) in terms of population densities in comparison to the non-connected ones. First of all, the data shows very low or almost zero correlations in 1884 between the indigenous and settler population density (in both the full and restricted samples) and the dummy variable for the treatment (equal to 1 if the region gained railway access and 0 if it did not).[43] Additionally, with respect to the settler population,

[41] As an exception, only one hamlet (*hameaux*) with 66 settlers had a school.

[42] Which is almost equivalent to 0.0002 per hectare in 1884 and 0.0005 in 1897.

[43] In the restricted sample the correlation between the settler population density and the treated variable in 1884 at a distance below 20 km is -0.05 (N=206) and -0.02 (N=206) for the one below 10 km. For the full sample the correlation is -0.02 (N=256) and 0.02 (N=256) respectively. The correlation in 1884 for the restricted sample between the indigenous population density and the treated dummy at less than 20 km is 0.08 (N=206) and 0.18 (N=206) for the distance below 10 km. In the full sample, the correlations are 0.002 (N=256) and 0.04 (N=256)

although Figure C.1 shows that the means of the non-connected regions are higher, a t-test on their differences for the restricted and full samples in the year 1884 are not significant at a 1 percent confidence level.[44] Furthermore, the box plot in Figure C.3 displays the variations in the total settler population sample in 1884. It shows that the median is approximately zero and that, despite numerous outliers, the highest value is of two settlers per hectare. Thus, it seems reasonable to assume that the railway in the regions under study was not attracted by a high settlement. With regard to the indigenous population, although the density is higher in the treated sample, the differences in means are also insignificant (except for the restricted sample at a distance below 10 km).[45] Thus, the correlations and mean differences suggest that the railway companies and the colonial administration in these locations were not based on population pre-conditions. However, the data available does not permit an examination of the pre-treatment trend, which would allow one to see whether the population growth rates were significantly different. As a final check, I also exclude from the sample the termini point (that is, population nuclei which were historic cities or endowed with natural resources).[46]

Methology and Results

The tables below show the baseline differences in means (and significance) accounting for both the restricted and full sample and with and without the termini points. The Tables 4.1 and 4.2 show that, with regard to the settler population, the share of observations in the treated sample range from 10 to 25 percent. The differences in means are negative and not significant for the years 1884 and 1892 but the t-values are not far from their critical values. The significance decreases for the period 1884 and 1897 and some values become positive. With respect to the indigenous population, the results displayed in Tables 4.3 and 4.4 show that the values are consistently positive, insignificant for the period 1884 and 1892, and for the period 1884 and 1897 the t-values are near the critical values. Thus, the results from these tables suggest that the effect of the railway was, in general, null for populations located in remote areas. However, the near-significance level of some estimates – the negative effect on settler density between 1884 and 1892 and the positive effect on the indigenous population between 1884 and 1897 – suggest that the results might become significant if the estimation methodology improves group comparability.

The effect of gaining railway access on population density is estimated by applying a cross-section regression by OLS for European and indigenous populations. The equation is the following:

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respectively.

[44] This result is consistent for the distance below 20 km and 10 km.

[45] But it is not significant at a 1 percent confidence level and the differences are not significant for the rest of cases.

[46] However, given that the analysis is also restricted to the relatively remote areas that were not a priority for railway construction, the number of termini points excluded from the sample is low.

$$PopDens_{i,t} = \beta_0 Rail_i + \beta_1 Dyear_t + \beta_2 X'_{i,t} + \beta_3 (DRail_{i,t} * Dyear_t) + \epsilon_{i,t}$$

The dependent variable is the population density for region *i* in year *t*, which can take the values 1884, 1892, and 1897. The equations will be separately estimated for the settler and indigenous population. The variable $DRail_{i,t}$ is a dummy variable equal to 1 if the region i experienced railway access between 1884 and 1892 (or 1884 and 1897) and 0 if not. The municipalities are divided into two subsamples depending on the proximity from the region's centroid to the nearest railway station (in a straight line): below 20 kilometers and below 10 kilometers. $Dyear_t$ is a dummy equal to 1 if the year is post-treatment (1892 or 1897) and 0 if it is the pre-treatment year (1884). As the number of observations is limited for both samples, particularly for the treatment group (see Tables 4.1 to 4.4), the number of control variables was restricted in vector X to the average elevation of the area under study. This is because, based on Algeria's history, it seems an accurate exogenous variable that reflects the differences in the geographic location and distribution of both populations: while settlers tended to settle on the coastal plains, the indigenous populations were relatively concentrated in the hilly areas (in particular, in the Kabylia region in the Eastern part of Constantine). In addition, it could have affected the probability of gaining access given that the gradient determined the speed of trains and increased fuel consumption and thus, was taken into consideration when building a line (Belkacemi, 1984). Finally, the diff-in-diff estimate is β_3.

Table 4.1: Base diff-in-diff: settler population density, Constantine 1884 and 1892

RESTRICTED SAMPLE					FULL SAMPLE							
No termini					With termini				No termini			
	N	1884	1892	1892-1884 (DD)	N	1884	1892	1892-1884 (DD)	N	1884	1892	1892-1884 (DD)
Distance from station < 20 km					Distance from station <20 km				Distance from station <20 km			
Treatment	49	0.13	0.115	-0.015	64	0.017	0.019	0.002	61	0.011	0.011	0.000
Control	157	0.243	1.086	0.843	192	0.023	0.033	0.010	191	0.018	0.024	0.006
T-C		-0.113	-0.97	-0.858		-0.006	-0.01	-0.008		-0.007	-0.013	-0.006
				(0.712)				(0.005)				(0.004)
Distance from station < 10 km					Distance from station < 10 km				Distance from station < 10 km			
Treatment	23	0.166	0.042	-0.124	37	0.027	0.030	0.003	34	0.018	0.018	0.000
Control	183	0.223	0.957	0.734	219	0.021	0.029	0.008	218	0.016	0.021	0.005
T-C		-0.057	-0.915	-0.858		0.006	0.001	-0.005		0.002	-0.003	-0.005
				(0.614)				(0.005)				(0.003)

In addition this section implements a propensity score matching to assure comparability between the groups by balancing them according to certain baseline characteristics (Stuart et al., 2014; Rosenbaum and Rubin, 1983; Stuart, 2010). This methodology estimates the probability of belonging to the treatment group in the baseline period using a multinomial logistic regression. That is, it predicts the probability of gaining access to the railway given the average elevation. It then assigns a weight to each observation based on the estimated probability, allowing the matching of the areas with similar probabilities so that it is possible to compare them. In other words, the treated areas are matched with the control sample areas that share similar characteristics so that the parallel trend assumption between both groups is more realistic. Hence,

Table 4.2: Base diff-in-diff: settler population density, Constantine 1884 and 1897

RESTRICTED SAMPLE					FULL SAMPLE							
No termini					With termini				No termini			
	N	1884	1897	1897-1884 (DD)	N	1884	1897	1897-1884 (DD)	N	1884	1897	1897-1884 (DD)
Distance from station < 20 km					Distance from station <20 km				Distance from station <20 km			
Treatment	49	0.13	0.769	0.639	64	0.017	0.028	0.011	61	0.011	0.019	0.008
Control	157	0.243	1.261	1.018	192	0.023	0.036	0.013	191	0.018	0.026	0.008
T-C		-0.113	-0.492	-0.379		-0.006	-0.01	-0.002		-0.007	-0.007	0.000
				(0.625)				(0.009)				(0.007)
Distance from station < 10 km					Distance from station < 10 km				Distance from station < 10 km			
Treatment	23	0.166	1.085	0.919	37	0.027	0.046	0.019	34	0.018	0.030	0.012
Control	183	0.223	1.152	0.929	219	0.021	0.032	0.011	218	0.016	0.023	0.007
T-C		-0.057	-0.067	-0.01		0.006	0.014	0.008		0.002	0.007	0.005
				(0.594)				(0.011)				(0.010)

Table 4.3: Base diff-in-diff: indigenous population density, Constantine 1884 and 1892

RESTRICTED SAMPLE					FULL SAMPLE							
No termini					With termini				No termini			
	N	1884	1897	1897-1884 (DD)	N	1884	1897	1897-1884 (DD)	N	1884	1897	1897-1884 (DD)
Distance from station < 20 km					Distance from station <20 km				Distance from station <20 km			
Treatment	49	0.347	0.441	0.094	64	0.298	0.380	0.082	61	0.295	0.382	0.087
Control	157	0.286	0.350	0.064	192	0.295	0.361	0.066	191	0.287	0.350	0.063
T-C		0.061	0.091	0.030		0.003	0.019	0.016		0.008	0.032	0.024
				(0.029)				(0.025)				(0.025)
Distance from station < 10 km					Distance from station < 10 km				Distance from station < 10 km			
Treatment	23	0.166	1.085	0.919	37	0.027	0.046	0.019	34	0.018	0.030	0.012
Control	183	0.223	1.152	0.929	219	0.021	0.032	0.011	218	0.016	0.023	0.007
T-C		-0.057	-0.067	-0.01		0.006	0.014	0.008		0.002	0.007	0.005
				(0.594)				(0.011)				(0.010)

Table 4.4: Base diff-in-diff: indigenous population density, Constantine 1884 and 1897

RESTRICTED SAMPLE					FULL SAMPLE							
No termini					With termini				No termini			
	N	1884	1897	1897-1884 (DD)	N	1884	1897	1897-1884 (DD)	N	1884	1897	1897-1884 (DD)
Distance from station < 20 km					Distance from station <20 km				Distance from station <20 km			
Treatment	49	0.347	0.478	0.131	64	0.298	0.420	0.122	61	0.295	0.412	0.117
Control	157	0.286	0.372	0.086	192	0.295	0.382	0.087	191	0.287	0.370	0.083
T-C		0.061	0.106	0.045		0.003	0.038	0.035		0.008	0.042	0.034
				(0.043)				(0.033)				(0.033)
Distance from station < 10 km					Distance from station < 10 km				Distance from station < 10 km			
Treatment	23	0.457	0.616	0.159	37	0.336	0.471	0.135	34	0.336	0.463	0.127
Control	183	0.281	0.370	0.089	219	0.289	0.378	0.089	218	0.282	0.367	0.085
T-C		0.176	0.246	0.070		0.047	0.093	0.046		0.054	0.096	0.042
				(0.046)				(0.029)				(0.030)

Tables 4.1, 4.2, 4.3, and 4.4: *** p<0.01; ** p<0.05; * p<0.1. Means and standard errors are estimated by linear regression. Clustered standard errors in parenthesis. *Source*: TGdC (1884), TGdC (1892), and TGdC (1897). For detail see Appendix D.

by taking advantage of GIS software, the average elevation (*elevation*) is included to estimate the propensity score.[47] This methodology should provide consistent estimates of the treatment effect if the bias is caused by the covariates included in the estimation.

[47]This methodology requires two assumptions regarding *elevation*: that of conditional independence (i.e., once you control for *elevation*, the potential density of population is independent of gaining railway access) and the common support (for each value of *elevation* the probability of being treated (or not) is positive).

Table C.4 in the Appendix C shows that, within the areas in which no settlers were located in 1884 (and thus in which there were no schools, churches, hospitals, etc.), the proximity to a railway station had a negative but insignificant effect on the settler density levels. In the full sample the value is null. Thus, increasing access in remote areas through the construction of the railway was not effective in terms of increasing settler population. Table C.6 shows that, though insignificant, the results change slightly if we broaden the year range up to 1897, becoming positive (particularly in the full sample) as we reach the areas closest to the railway station. Overall, the results suggest that gaining railway access in these remote regions had no effect on the settlement population density.

With respect to indigenous population density for the years 1882 and 1892, Table C.5 reflects that in both the restricted and full sample the effect of the railway increases as the region gets nearer to the station, but it is not significant. The results shown in Table C.7 for the years 1884 and 1897 display higher values in general and, although all of them are not far from the t-values, they are only significant in the full sample when the distance is below 10 km and if the termini points are included. Thus, the results obtained show that the railway had a positive and significant effect on the indigenous population only in the regions that already had settlers and were closer to the railway station.

In addition to the propensity score matching technique, based on the box plots in Appendix C (Figures C.3 and C.4), I drop the areas endowed with extreme outside values of indigenous population density (I set the limit above the value of 2). This should increase the similarity between the control and treatment groups. The main difference from the previous results is that the settler population, as displayed in Table C.10, becomes significant in the full sample between the years 1884 and 1897. The indigenous population, as shown in Tables C.9 and C.11, does not seem to be affected by the construction of the railway and thus the prior results were likely affected by the outside values. Hence, if the latter are excluded, the settlers were positively affected by the infrastructure and the indigenous population was not.

As a final check and in line with authors such as Atack et al. (2010); Banerjee et al. (2012,?); Berger and Enflo (2015), I carry out an instrumental variable approach. Although I have argued that the railway infrastructure in the regions analyzed was built based on reasons exogenous to population levels, there might be variables explaining the population density levels that could have also affected the probability of gaining access to the railway. This is why it is necessary to find an exogenous variable that predicts gaining railway access but that does not correlate to indigenous and settler population density.

I created a dummy variable equal to 1 if the region has any natural resources or if it is a strategic location, and equal to 0 in the opposite case. To do this I extracted the data from the 1878 *Dictionnaire des Communes, Villes & Villages de l'Algérie* (DCVVA), a report containing information on the administrative condition, the geographic situation, and facilities such as the number of schools, prisons, courts, gendarmeries, banks, etc.[48] The variable is equal to 1 if it

[48]Occasionally, this process required interpretation of the data in order to complement some information. For

has natural resources such as silver mines, antimony, iron, salt, cedar, oak forests, lead, and 16 thousand palm trees (in the case of El-Kantara). The dummy variable is also equal to 1 if the region is of strategical relevance. For example, whether it has a primary fort such as the one in Constantine, if the region was projected to be populated, if it was a military subdivision (Batna and Sétif), a geographically strategic position (for instance, Biskra was an on the way to the South and in the proximities of the *Caïdat* and an oasis), or relevant Arab markets for commercial exchange.[49] As Figure C.5 shows, I then drew straight lines linking each of them to the nearest one or to the closest important port (i.e., Bône, Philippeville, and Bougie),[50] avoiding the mountainous regions (trying to capture the least costly and most feasible route).

As shown in the pair-wise correlation matrix in the Appendix C, the correlation between the instrument and the population density levels is null, whereas it is high (above 50 percent) and significant (at a 1 percent confidence level) with respect to the treatment variable (i.e., *D<20km* and *D<10 km*). The results using the instrumental variable displayed in Tables C.12 and C.13 provide similar insights: gaining railway access in remote areas was ineffective with regards to settlement expansion, particularly in the areas with no settlers in 1884 (and thus no colonial infrastructure development). However, the results do show a positive and significant effect on the indigenous population density. The full sample, which includes the settlement centers and thus captures the regions with colonial agriculture, suggests that indigenous population growth did respond to the infrastructure in the regions where demand for labor was higher. Thus, the results suggest that the construction of railway lines allowed the demand for indigenous labor to meet the supply more "easily." However, this conclusion is hypothetical given that there is no sub-municipal data on agricultural production. Nonetheless, if I relate the data at a municipal level from the SA to the sub-municipal one used in this chapter it is possible to support the "labor demand" hypothesis argued by Bennoune (2002); Coontz (1957); Ruedy (2005): the correlation, conditional to the regions that gained access to the railway, between indigenous population

instance, in the case of Tébessa it was useful to look at the posterior 1903 DCVVA regarding natural resources or military strategy. Additionally, sometimes names of locations appeared duplicated; for example, El-Ghedir, is reported as a hamlet on the route between Bône and Souk-Ahrás and as a *douar* in the CM El-Arrouch.

[49] I include Sigus as it was on the route between Constantine and Aïn Beïda and was being populated prior to the construction of the railway (Bône). Similarly, I include Sidi Mesrich, that was on the route between Bône and Constantine and being populated. I also include a strategic passage that was key to the Alger-Constantine route between mountains named Ports-de-Fer in Bibans. Tébessa is included as it was a gateway to the south and the frontier with Tunisia, and in 1903 it was considered to have abundant water and plains and buildings constructed before 72 AC. Souk Ahrás is included as it appears on the national projected route from Constantine to Tunisia and is endowed with lead, copper, and zinc mines. I Include Bordj Bou Arreridj as it has a military post but also a sandstone quarry of easy cut stone and is on the way between Sétif and Alger. I also include three Arab markets which should capture important traditional exchange areas. I do not include military posts in remote areas that are not on the way to any strategic location (such as Takitount or M'Sila). Nor do I include Tizi N'Bechar which, despite being populated, is too remote and does not go to any strategic region.

[50] The main port in Constantine was Bône, followed by Philippeville and Bougie. These were built during French occupation for military purposes and after the 1850s trade began to expand, particularly because of tariff changes. I do not include the tertiary ports Djidjelli, Collo, Herbillon and La Calle. Additionally, even though some of these tertiary ports were endowed with natural resources (near La Calle there was a rich lead mine and next to Collo there was an important forest), they are not included given that transport by sea was cheaper than building a whole railway line that would link them to the main ports.

density (at a settlement center or *douar* level) and the indigenous wages per day (at a municipal level) is negative and significant, and that with respect to the share of wine-cultivated hectares over the total settler cultivated area is positive and significant.[51]

Finally, it is unclear whether the population changes brought in by the railway reflect increases in natural growth rates as a response to the creation of newer economic activity, or if they are simply accounting for the displacement of population. If the effect is partly explained by the redistribution of economic activity across regions, then the coefficients obtained should be overestimating the impact of the railway on population. Thus, following a similar methodology as the one used by Berger (2016) and Redding and Turner (2014), I selected a baseline regression – I chose the propensity score diff-in-diff model where the treated group are the regions below 10 km from the nearest railway station – and drop the nearby areas sequentially to see if the coefficients change significantly. If part of the explanation is redistribution of population, then the coefficients would decrease. This is because the regions experiencing the outward movement of population are dropped from the control group decreasing the differential effect of the railway.[52] The tables C.14 and C.15 display these results. With regards to the settler population, the size of the coefficients shows a strong decrease only when the regions below 20 km are dropped in the restricted sample.[53] The indigenous population density decreases when the regions below 10 km are excluded but the coefficients do not change significantly. These results support that the redistribution of population into the nearby regions also explains the observed changes.

4.4 Conclusions

There is extensive research that demonstrates that gaining railway access had a positive effect on economic growth by allowing previously unconnected regions to gain competitive advantage and integrate in the market economy. Yet few studies examine the regions that were unable to do so. This chapter studies the effect of the railway infrastructure on population densities in "remote" or "marginal" regions – that is, those not prioritized by the colonial administration and that gained access during a "second wave" of construction in the 1880s – in the Constantine region in French Algeria. To do this, I have used a diff-in-diff model on two time intervals (1884-1892 and 1884-1897) and improved the accuracy of comparison between the treated and the control groups by matching the observations based on a propensity score matching technique. The results show that the railway effect was mainly insignificant. On the one hand, the settler

[51] At a distance lower than 10 km, the correlation is -0.29 with indigenous wages and 0.30 with the share of wine over the total cultivated area. At a distance below 20 km, the correlation is -0.23 and 0.46 respectively.

[52] If there is redistribution, then there will be a stronger population difference between the treatment group (with higher levels as it receives the population inflows) and the control group (with lower levels as it experiences the outflows). But if we progressively drop from the control group the nearby regions that potentially experienced the outflows, then the difference should decrease, while if there is no redistribution the coefficient is solely accounting for natural growth.

[53] This result must be regarded with extreme caution as the number of settler in the restricted sample is extremely low and thus the results are very vulnerable to changes.

population density displayed negative values and did not benefit from the infrastructure. On the other hand, the indigenous population, with consistently positive growth rates, responded positively to the railway only in the regions nearest to the stations (at a distance of ten kilometers or less) and where settlers were already located.

Overall, these results are consistent with the existing literature on Algerian railways. The insignificant effects can mainly be explained by the high levels of and regional differences in the prices of tariffs and their complex structures, which ultimately highlighted regional inequalities within Constantine itself. The estimated size of the coefficients is likely inaccurate due to the difficulty in measuring the populations in these areas during the colonial period, and in particular the one regarding the indigenous population.[54] However, the signs are in line with the historiography. The negative effect with respect to the settler population confirms the "crowding out" of the small rural settlers and the administration's failure to consolidate a small farm economy. Furthermore, as explained previously, the high and multiple tariffs disadvantaged small producers. With respect to the indigenous population, the positive effect is logical given that, as Good (1961) explains, after the critical years prior to 1872 in which population decreased (caused by epidemics, drought, famine, and the Kabylia rebellion), growth rates recovered and displayed continuous positive figures due to natural population growth. According to some authors, such as Bennoune (2002) and Ruedy (2005), persistent growth rates within an impoverished context (i.e., the cultivable land was expropriated and exhausted, the tribal areas had been legally circumscribed, and the tax burden was extremely high) were only feasible if the demand for labor was strong enough. These results support this view and show that indigenous population growth was positively affected by the railway only in the regions settled by Europeans and nearest to the railway stations.

[54] See Appendix D for more detail on coverage and data problems.

Chapter 5

Conclusion

This thesis uses newly collected agricultural data for the Constantine department in French Algeria at the turn of the twentieth century to disentangle the mechanisms through which some variables – commonly regarded as the "colonial origins" of land inequality within standard economic history and development research – shape agrarian structures in settler economies. In contrast to numerous studies that neglect within country differences in colonial land appropriation and redistribution policies, this study relies upon these differences to understand the process of settlement. By analyzing the regional variation in the timing of settlement, one can see more clearly the mechanisms through which geography, factor endowments, and institutions interact and shape rural economies.

Chapter 2 focuses on the institutional determinants of rural settlement. It examines the relation between agricultural settler density – a variable that accounts for the French rural settlement failure – and property size distribution at a municipal level. It argues that the institutional restrictions on property size – which were particularly strict during the nineteenth century as a result of the state-organized settlement policy – had a progressively weaker direct influence on family farm settlement, ultimately allowing land amalgamation in the later settled (or frontier) regions and thus help explain the crowding-out of small family settlers. In addition, the results show that a higher density of road infrastructure, mostly built by colonial institutions, also played an important role, having a positive effect on rural settlers and hindering land concentration. Finally, although it is not possible to make any causality conclusions, the inclusion of indigenous owners (as a proxy for indigenous agency) shows that the latter positively related to family farm settlers. Overall, the results suggest that the institutional variables – channeled through land policies and infrastructures – had the strongest effect on the outcome of rural settlement and land concentration.

From a different perspective, Chapter 3 examines local endowments – that is, the relative supply of production factors – to explain the higher presence of large ownership in the frontier regions. It argues that settlers, in order to innovate and cultivate the more arid frontier regions, needed to adopt labor intensive agricultural techniques. However, given the limited possibilities

to reduce production costs in the frontier, the relative high labor-to-land ratios were essential to participate in cash crop grain production. Thus, agricultural intensification in the frontier ultimately depended on the colonial land expropriation policies that facilitated a labor surplus and decreased restrictions on property size. In addition, the modern farming techniques required a larger capital investment, including the purchase of land, buying and feeding draft animals, agricultural machinery, seasonal labor, interests on capital, repairs and machinery depreciation, which ultimately explains the lower small family farm settler density.

Following the conclusions in Chapter 2 suggesting that road infrastructure hindered land concentration and positively affected rural settlers, Chapter 4 examines whether the railway – the most significant colonial investment – had a also a positive effect on rural settlement in the relatively remote and mostly tribal regions that were not prioritized by the colonial administration and thus gained access only during a "second wave" of construction in the 1880s. In contrast to numerous research finding that gaining rail access had a positive effect on population densities, the results show that the effect was insignificant. This is in line with studies arguing that the high and multiple tariffs in Constantine increased regional inequalities and disadvantaged small producers. In addition, I find that the indigenous population, which consistently displayed positive growth rates, was positively affected by the railway only in the regions nearest to the stations (below ten kilometers) and where settlers were already located. This suggests that the railway worked as a colonial instrument that facilitated labor surplus, having an effect on indigenous populations only in the regions where the demand for labor was big enough.

The hypotheses provided in economic history on the transmission channels from colonial legacies to long term growth and development tend to oversimplify reality. However, they allow building more complex conceptual frameworks. This thesis provides a more detailed analysis as to how institutions and factor endowments interacted in a settler economy. Chapter 2 focuses directly on the land market policies introduced with colonialism. As Frankema (2010, p. 421) explains, the "metropolitan institutions perspective" set forth by North et al. (2000) states that colonial land distribution was mainly determined by "metropolitan objectives, preferences, and traditions, rather than by local conditions." Yet, the case of French Algeria shows that land market policies had to adapt to Algeria's land aridity and ultimately sacrifice the ideal of a small family farm economy (by means of withdrawing regulations on property size). This highlights how factor endowments affect structure of landholdings through institutions (Engerman and Sokoloff, 2002; Easterly, 2007; Acemoglu et al., 2001; Fenske, 2014). On the other hand, Chapter 3 shows how innovation in agricultural production helped overcome geographic constrains in the frontier regions. Yet, in line with research linking agricultural intensification and the land-to-labor ratio in pre-industrial societies (Boserup, 1965), innovation depended on indigenous labor availability. The institutional land expropriation policies helped release this labor into the large and extensive landholdings at the frontier. In addition, the results in the last chapter suggest that the colonial railway facilitated indigenous labor in settlement centers. This demonstrates how institutions altered the relative factor endowments, affecting modes of production and thus, land

concentration and rural settlement.

This thesis has clearly some limitations which call for further research. To simplify the analysis, it has only investigated one side of the settlement story – that of settlers – and neglected the indigenous one; namely, the role of pre-colonial institutions and the participation of the indigenous populations in the production process (Fenske, 2014; Frankema et al., 2014; Green, 2013). Therefore, the next step to fully comprehend settlement in Algeria is to examine the role of indigenous agency. In addition, the time span of this study is very limited. Indeed, the years analyzed belong to a period characterized by economic growth in the Maghreb region. Angus Maddison, based on Samir Amin's 1966 estimates, finds that Algerian GDP almost doubled between 1880 and 1913 (Amin, 1966; Maddison, 2006). These positive figures are given for all North African countries and are supported by alternative estimates provided by researchers aiming to fill the gap regarding long-term GDP trends (Prados de la Escosura, 2012). However, what the research has not made clear is the extent to which this marked increase in economic growth during the colonial years went hand-in-hand with a growing land inequality. Thus, the short-term framework of this thesis is a first step towards understanding how Algeria's land distribution before independence affected local capabilities in agriculture, commerce and political governance, and how, after Independence, this conditioned through various channels the local, regional and, ultimately, national development paths into the present.

Appendix A

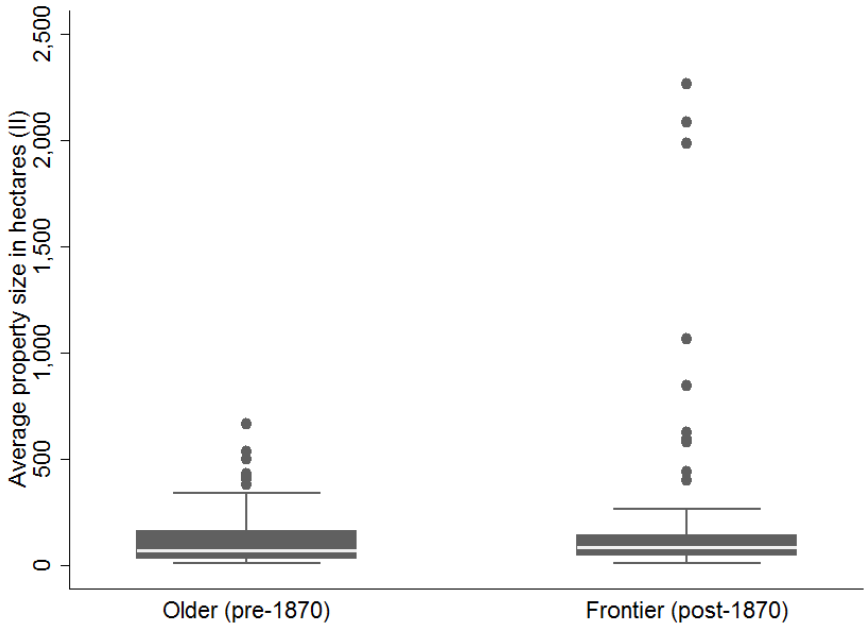
Appendix: Chapter 2

Table A.1: Summary statistics in Chapter 2

Variable	Mean	Std. Dev.	N
EurAgricPop_ha	0.088	0.14	199
Creation	1867.24	15.386	200
IndexLC	3.692	1.213	197
AverPropSize (I)	46.45	22.524	197
AverPropSize (II)	155.277	284.57	197
ShareProp>41ha	0.423	0.314	197
GINI	0.254	0.194	197
RoadNetwork	1.992	1.487	200
ShortPthRW	3.918	3.312	196
CropSuit	6.121	1.464	200
Sett/Ind_84	0.215	0.392	200
DWine	0.820	0.385	200
DYear	0.5	0.501	200
DType	0.72	0.45	200
IndigOwnersDens	0.298	0.479	197
IndigOwnersShare	0.352	0.297	199
D_< 10ha	0.65	0.478	200
D_11< ha< 20	0.695	0.462	200
D_21< ha< 30	0.75	0.434	200
D_31< ha< 40	0.795	0.405	200
D_41< ha< 100	0.9	0.301	200
D_> 100ha	0.87	0.337	200

These values are for Constantine in the years 1904/05 and 1913/14. See Appendix D for detail on the construction of variables and sources.

Figure A.1: Box plot of the average property size (by year of settlement), Constantine in 1904/05 and 1913/14



AverPropSize(II) is the ratio between the number of European-owned hectares and the number of European-owned properties. *Source*: SA (1904/05, 1913/14), Busson (1898), ANOM-iREL. See Appendix D for more detail on the construction on variables and sources.

Table A.2: Pair-wise correlation matrix in Chapter 2

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
(1) EurAgricPop_ha	1.000															
(2) Creation	-0.252	1.000														
	(0.000)															
(3) IndexLC	-0.343	0.455	1.000													
	(0.000)	(0.000)														
(4) AverPropSize (I)	-0.333	0.388	0.973	1.000												
	(0.000)	(0.000)	(0.000)													
(5) AverPropSize (II)	-0.197	0.085	0.281	0.323	1.000											
	(0.006)	(0.237)	(0.000)	(0.000)												
(6) ShareProp>41ha	-0.300	0.329	0.888	0.956	0.325	1.000										
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)											
(7) GINI	-0.125	-0.040	0.099	0.182	0.106	0.156	1.000									
	(0.081)	(0.573)	(0.166)	(0.010)	(0.138)	(0.029)										
(8) RoadNetwork	0.237	-0.408	-0.307	-0.269	-0.154	-0.240	0.044	1.000								
	(0.001)	(0.000)	(0.000)	(0.000)	(0.031)	(0.001)	(0.538)									
(9) ShortPthRW	-0.212	0.231	0.263	0.248	-0.018	0.212	0.059	-0.366	1.000							
	(0.003)	(0.001)	(0.000)	(0.000)	(0.806)	(0.003)	(0.414)	(0.000)								
(10) CropSuit	-0.089	-0.164	0.057	0.025	-0.112	-0.003	0.005	0.090	-0.262	1.000						
	(0.212)	(0.020)	(0.423)	(0.725)	(0.118)	(0.970)	(0.945)	(0.205)	(0.000)							
(11) Sett/Ind_84	0.396	-0.295	-0.181	-0.134	-0.014	-0.105	0.105	0.296	-0.207	-0.084	1.000					
	(0.000)	(0.000)	(0.011)	(0.060)	(0.842)	(0.143)	(0.144)	(0.000)	(0.004)	(0.240)						
(12) DWine	0.062	-0.232	-0.154	-0.157	0.089	-0.208	0.056	0.286	-0.518	0.551	0.087	1.000				
	(0.384)	(0.001)	(0.031)	(0.027)	(0.212)	(0.003)	(0.430)	(0.000)	(0.000)	(0.000)	(0.222)					
(13) DYear	-0.067	0.000	0.038	0.046	-0.027	0.053	0.367	0.000	0.000	0.000	0.000	0.000	1.000			
	(0.349)	(1.000)	(0.597)	(0.519)	(0.707)	(0.462)	(0.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)				
(14) DType	0.105	-0.655	-0.299	-0.236	-0.094	-0.199	0.101	0.468	-0.202	0.222	0.202	0.288	0.000	1.000		
	(0.140)	(0.000)	(0.000)	(0.001)	(0.189)	(0.005)	(0.158)	(0.000)	(0.005)	(0.002)	(0.004)	(0.000)	(1.000)			
(15) Owners/ha_I	0.296	-0.112	-0.187	-0.168	-0.115	-0.136	0.036	0.215	-0.192	-0.127	0.180	0.111	0.046	-0.011	1.000	
	(0.000)	(0.117)	(0.009)	(0.019)	(0.108)	(0.058)	(0.617)	(0.002)	(0.007)	(0.076)	(0.012)	(0.119)	(0.525)	(0.873)		
(16) ShareOwners_I	0.092	0.205	0.060	0.023	-0.121	0.001	-0.019	-0.224	0.067	-0.086	-0.010	-0.201	0.078	-0.427	0.506	1.000
	(0.197)	(0.004)	(0.407)	(0.750)	(0.091)	(0.988)	(0.791)	(0.001)	(0.353)	(0.226)	(0.887)	(0.004)	(0.275)	(0.000)	(0.000)	

Standard deviation in parenthesis. See Appendix D for more detail on the construction of variables and sources.

Table A.3: Number of settlers and year of creation of settlement centers in Constantine (Busson, 1898)

Before 1870			After 1870		
Settlers	Creation	Source	Settlers	Creation	Source
121	1853	Census between 1851 and 1888	151	1872	Census between 1851 and 1888
153	1860	Census between 1851 and 1888	45	1872	Census between 1851 and 1888
162	1862	Census between 1851 and 1888	79	1872	Census between 1851 and 1888
136	1847	Census in 1851	244	1872	Census between 1851 and 1888
71	1856	Census between 1851 and 1888	176	1877	Census between 1851 and 1888
81	1856	Census between 1851 and 1888	346	1874	Census between 1851 and 1888
108	1853	Census between 1851 and 1888	420	1872	Census between 1851 and 1888
131	1853	Census between 1851 and 1888	274	1876	Census between 1851 and 1888
91	1856	Census between 1851 and 1888	217	1881	Census between 1851 and 1888
232	1855	Census between 1851 and 1888	18	1896	Reported at creation of center
486	1848	Census in 1851	112	1882	Census between 1851 and 1888
343	1862	Census between 1851 and 1888	64	1892	Reported at creation of center
316	1848	Census in 1851	151	1873	Census between 1851 and 1888
122	1847	Census in 1851	536	1874	Census between 1851 and 1888
150	1845	Census in 1851	29	1877	Census between 1851 and 1888
376	1848	Census in 1851	116	1877	Census between 1851 and 1888
315	1848	Census in 1851	260	1872	Census between 1851 and 1888
139	1847	Census in 1851	190	1880	Census between 1851 and 1888
89	1860	Census between 1851 and 1888	339	1885	Census between 1851 and 1888
39	1849	Census in 1851	171	1881	Census between 1851 and 1888
512	1848	Census in 1851	203	1875	Census between 1851 and 1888
115	1847	Census in 1851	69	1892	Reported at creation of center
350	1847	Census in 1851	128	1875	Census between 1851 and 1888
420	1847	Census in 1851	218	1874	Census between 1851 and 1888
252	1844	Census in 1851	145	1874	Census between 1851 and 1888
650	1841	Census in 1851	328	1870	Census between 1851 and 1888
108	1844	Census in 1851	56	1874	Census between 1851 and 1888
46	1844	Census in 1851	163	1873	Census between 1851 and 1888
178	1844	Census in 1851	205	1873	Census between 1851 and 1888
67	1858	Census between 1851 and 1888	99	1874	Census between 1851 and 1888
164	1854	Census between 1851 and 1888	104	1872	Census between 1851 and 1888
195	1848	Census in 1851	216	1875	Census between 1851 and 1888
169	1852	Census between 1851 and 1888	67	1875	Census between 1851 and 1888
173	1845	Census in 1851	435	1872	Census between 1851 and 1888
208	1848	Census in 1851	49	1877	Census between 1851 and 1888
189	1850	Census in 1851	45	1883	Census between 1851 and 1888
196	1857	Census between 1851 and 1888	216	1884	Census between 1851 and 1888
151	1847	Census in 1851	115	1883	Census between 1851 and 1888
182	1856	Census between 1851 and 1888	85	1880	Census between 1851 and 1888
17	1859	Census between 1851 and 1888	171	1881	Census between 1851 and 1888
264	1859	Census between 1851 and 1888	311	1897	Reported at creation of center
164	1859	Census between 1851 and 1888	88	1887	Census between 1851 and 1888
60	1854	Census between 1851 and 1888	63	1887	Census between 1851 and 1888
97	1857	Census between 1851 and 1888	112	1872	Census between 1851 and 1888
173	1863	Census between 1851 and 1888	218	1878	Census between 1851 and 1888
92	1865	Census between 1851 and 1888	221	1890	Reported at creation of center
87	1853	Census between 1851 and 1888	178	1887	Census between 1851 and 1888
83	1869	Census between 1851 and 1888	257	1890	Reported at creation of center
46	1853	Census between 1851 and 1888	240	1883	Census between 1851 and 1888
After 1870					
212	1879	Census between 1851 and 1888	281	1877	Census between 1851 and 1888
170	1887	Census between 1851 and 1888	429	1877	Census between 1851 and 1888
227	1894	Reported at creation of center	149	1882	Census between 1851 and 1888
199	1880	Census between 1851 and 1888	139	1874	Census between 1851 and 1888
20	1895	Reported at creation of center	155	1874	Census between 1851 and 1888
73	1873	Census between 1851 and 1888	62	1891	Reported at creation of center
56	1879	Census between 1851 and 1888	144	1878	Census between 1851 and 1888
89	1891	Reported at creation of center	404	1873	Census between 1851 and 1888
147	1891	Reported at creation of center	290	1872	Census between 1851 and 1888
305	1886	Census between 1851 and 1888	112	1874	Census between 1851 and 1888
52	1890	Reported at creation of center	162	1878	Census between 1851 and 1888
850	1874	Census between 1851 and 1888	324	1878	Census between 1851 and 1888
11	1880	Census between 1851 and 1888	165	1876	Census between 1851 and 1888
93	1887	Census between 1851 and 1888	92	1876	Census between 1851 and 1888
302	1889	Reported at creation of center	138	1886	Census between 1851 and 1888
			212	1879	Census between 1851 and 1888

Source: Busson (1898). All values from centers created prior to 1851 correspond to the 1851 census. The values between 1851 and 1888 come from the: i. 1861 census if between 1851-1861, ii. 1871 census if between 61-71, iii. 1877 census if between 71-77, and iv. 1888 census if between 77-88.

Table A.4: Determinants of European agricultural population, Constantine in 1904/05 and 1913/14

Dependent variable: European agricultural population per hectare (*EurAgrPop/ha_i,t*)										
	OLS (1a)	2SLS (1b)	OLS (2a)	2SLS (2b)	OLS (3a)	2SLS (3b)	OLS (4a)	2SLS (4b)	OLS (5a)	2SLS (5b)
AverPropSize(I)	-0.021***	-0.034**	-0.020***	-0.034*	-0.021***	-0.034*	-0.020***	-0.032*	-0.020***	-0.032*
	(0.003)	(0.016)	(0.003)	(0.019)	(0.004)	(0.019)	(0.002)	(0.019)	(0.003)	(0.019)
ShortPthRW	-0.039	-0.024	-0.037	-0.024	-0.036	-0.022	-0.031	-0.021	-0.035	-0.023
	(0.037)	(0.028)	(0.038)	(0.028)	(0.037)	(0.028)	(0.030)	(0.020)	(0.037)	(0.027)
CropSuit	0.091	0.120	0.081	0.119	0.081	0.119	0.136	0.166*	0.077	0.114
	(0.080)	(0.092)	(0.078)	(0.103)	(0.077)	(0.102)	(0.074)	(0.099)	(0.078)	(0.104)
RoadNetwork	0.166*	0.139*	0.166*	0.139*	0.168*	0.142*	0.131**	0.110*	0.170*	0.144*
	(0.071)	(0.073)	(0.071)	(0.075)	(0.071)	(0.075)	(0.050)	(0.066)	(0.073)	(0.081)
DWine	-0.649	-0.695*	-0.639	-0.694	-0.640	-0.697*	-0.759	-0.802**	-0.591	-0.652
	(0.458)	(0.409)	(0.461)	(0.424)	(0.456)	(0.418)	(0.439)	(0.406)	(0.469)	(0.443)
DYear	-0.013	0.019	-0.014	0.018	-0.013	0.019	-0.027	0.004	-0.038	-0.003
	(0.081)	(0.107)	(0.080)	(0.111)	(0.081)	(0.113)	(0.074)	(0.109)	(0.084)	(0.118)
DType	-0.357	-0.456*	-0.334	-0.454*	-0.347	-0.474	-0.286	-0.396	-0.199	-0.337
	(0.201)	(0.240)	(0.203)	(0.273)	(0.217)	(0.300)	(0.180)	(0.241)	(0.251)	(0.314)
Sett/Ind_84			-0.251	-0.016	-0.282	-0.059	0.077	0.284	-0.144	0.059
			(0.370)	(0.455)	(0.391)	(0.418)	(0.227)	(0.333)	(0.338)	(0.439)
D_K					-0.078	-0.112				
					(0.194)	(0.216)				
Owners/ha_I							0.527***	0.498***		
							(0.129)	(0.183)		
ShareOwners_I									0.491*	0.403
									(0.243)	(0.315)
Constant	-1.945**	-1.431	-1.976**	-1.436	-1.955**	-1.403	-2.328***	-1.820	-2.278***	-1.713
	(0.526)	(1.037)	(0.552)	(1.147)	(0.588)	(1.198)	(0.449)	(1.129)	(0.599)	(1.249)
N	193	193	193	193	193	193	191	191	193	193
R^2	0.29	0.23	0.30	0.23	0.30	0.23	0.34	0.29	0.31	0.25
R2_A	0.27	0.20	0.26	0.19	0.26	0.19	0.31	0.25	0.28	0.21

*Significant at 10%; **significant at 5%; *** significant at 1%. Cluster-robust standard errors in parentheses. *OLS* is Ordinary Least Squares and 2SLS is Two Stage Least Square. *AverPropSize(I)* is the variable measuring land concentration. In 2SLS the *AverPropSize(I)* is instrumented with *Creation*. Dependent variable is in logarithms. *Source*: SA (1904/05, 1913/14), Busson (1898), ANOM-iREL, and GIS databases. See Appendix D for more detail on the construction of variables and sources.

Table A.5: Determinants of European Agricultural Population, Constantine in 1904/05 and 1913/14

	OLS (1a)	2SLS (1b)	OLS (2a)	2SLS (2b)	OLS (3a)	2SLS (3b)	OLS (4a)	2SLS (4b)	OLS (5a)	2SLS (5b)
AverPropSize(I)	-0.014***	-0.034**	-0.013**	-0.034*	-0.013**	-0.034*	-0.013***	-0.032*	-0.013***	-0.033*
	(0.003)	(0.016)	(0.004)	(0.018)	(0.004)	(0.018)	(0.002)	(0.018)	(0.003)	(0.018)
ShortPthRW	-0.042	-0.022	-0.039	-0.022	-0.038	-0.021	-0.034	-0.019	-0.037	-0.021
	(0.039)	(0.030)	(0.040)	(0.030)	(0.039)	(0.030)	(0.033)	(0.022)	(0.039)	(0.029)
CropSuit	0.079	0.121	0.065	0.121	0.065	0.121	0.119	0.168*	0.063	0.116
	(0.075)	(0.089)	(0.070)	(0.097)	(0.070)	(0.097)	(0.066)	(0.094)	(0.071)	(0.097)
RoadNetwork	0.135	0.130**	0.136	0.130**	0.137	0.132**	0.102	0.100**	0.140	0.134**
	(0.083)	(0.063)	(0.084)	(0.063)	(0.084)	(0.062)	(0.059)	(0.044)	(0.086)	(0.065)
DWine	-0.598	-0.691*	-0.583	-0.691*	-0.585	-0.694*	-0.701	-0.797**	-0.547	-0.653
	(0.397)	(0.403)	(0.394)	(0.417)	(0.388)	(0.410)	(0.369)	(0.401)	(0.409)	(0.427)
DYear	-0.021	0.021	-0.023	0.021	-0.022	0.022	-0.028	0.010	-0.042	0.001
	(0.098)	(0.107)	(0.097)	(0.110)	(0.098)	(0.111)	(0.087)	(0.101)	(0.101)	(0.113)
DType	-0.230	-0.444*	-0.196	-0.444	-0.210	-0.465	-0.155	-0.387	-0.094	-0.336
	(0.173)	(0.260)	(0.185)	(0.298)	(0.203)	(0.324)	(0.156)	(0.267)	(0.220)	(0.325)
D_Aver>100ha	-0.578***	-0.114	-0.589***	-0.114	-0.590***	-0.113	-0.573***	-0.124	-0.561**	-0.110
	(0.133)	(0.354)	(0.132)	(0.401)	(0.137)	(0.410)	(0.139)	(0.431)	(0.152)	(0.418)
Sett/Ind_84			-0.340	-0.001	-0.374	-0.046	-0.049	0.294	-0.251	0.067
			(0.434)	(0.405)	(0.444)	(0.374)	(0.315)	(0.302)	(0.419)	(0.411)
D_K					-0.085	-0.118				
					(0.194)	(0.204)				
Owners/ha_I							0.479***	0.482***		
							(0.124)	(0.187)		
ShareOwners_I									0.393	0.371
									(0.269)	(0.363)
Constant	-2.013**	-1.377	-2.056**	-1.377	-2.034**	-1.343	-2.397***	-1.746*	-2.294**	-1.634
	(0.619)	(0.961)	(0.651)	(1.033)	(0.691)	(1.080)	(0.546)	(0.988)	(0.707)	(1.102)
N	193	193	193	193	193	193	191	191	193	193
R^2	0.34	0.23	0.35	0.23	0.35	0.23	0.39	0.28	0.36	0.25
R2_A	0.31	0.19	0.32	0.19	0.31	0.18	0.35	0.24	0.32	0.21

*Significant at 10%; **significant at 5%; *** significant at 1%. Cluster-robust standard errors in parentheses. *OLS* is Ordinary Least Squares and 2SLS is Two Stage Least Square. *AverPropSize(I)* is the variable measuring land concentration. *D_Aver>100ha* is a dummy variable equal to 1 if the average property size per municipality is above 100 hectares (calculated from a different source than that used for *AverPropSize(I)*). In 2SLS the *AverPropSize(I)* is instrumented with *Creation*. Dependent variable is in logarithms. *Source*: SA (1904/05, 1913/14), Busson (1898), ANOM-iREL, and GIS databases. See Appendix D for more detail on the construction of variables and sources.

Table A.6: Determinants of European Agricultural Population, Constantine in 1904/05 and 1913/14

	OLS (1a)	2SLS (1b)	OLS (2a)	2SLS (2b)	OLS (3a)	2SLS (3b)	OLS (4a)	2SLS (4b)	OLS (5a)	2SLS (5b)
AverPropSize(I)	-0.017***	-0.033**	-0.017***	-0.033*	-0.017***	-0.034*	-0.017***	-0.032*	-0.017***	-0.033*
	(0.003)	(0.017)	(0.003)	(0.019)	(0.003)	(0.019)	(0.002)	(0.019)	(0.002)	(0.019)
ShortPthRW	-0.045	-0.026	-0.042	-0.026	-0.041	-0.024	-0.037	-0.023	-0.041	-0.025
	(0.029)	(0.024)	(0.031)	(0.024)	(0.030)	(0.024)	(0.026)	(0.018)	(0.031)	(0.024)
CropSuit	0.028	0.077	0.018	0.078	0.017	0.078	0.071	0.123	0.016	0.075
	(0.095)	(0.110)	(0.088)	(0.120)	(0.087)	(0.119)	(0.087)	(0.120)	(0.089)	(0.121)
RoadNetwork	0.133**	0.110**	0.134**	0.110*	0.136**	0.113*	0.104**	0.084	0.138**	0.114*
	(0.052)	(0.056)	(0.052)	(0.058)	(0.053)	(0.059)	(0.041)	(0.052)	(0.055)	(0.062)
DWine	-0.361	-0.486	-0.351	-0.488	-0.351	-0.490	-0.474	-0.594	-0.319	-0.457
	(0.425)	(0.454)	(0.424)	(0.473)	(0.411)	(0.460)	(0.418)	(0.469)	(0.428)	(0.483)
DYear	-0.091	-0.035	-0.092	-0.035	-0.093	-0.034	-0.102	-0.046	-0.110	-0.051
	(0.078)	(0.122)	(0.077)	(0.128)	(0.077)	(0.129)	(0.074)	(0.125)	(0.077)	(0.131)
DType	-0.432**	-0.528**	-0.407*	-0.531**	-0.428*	-0.558*	-0.360**	-0.476**	-0.293	-0.436
	(0.171)	(0.245)	(0.173)	(0.268)	(0.199)	(0.302)	(0.145)	(0.241)	(0.226)	(0.323)
D_Aver>500ha	-1.662**	-1.252	-1.664**	-1.250	-1.678**	-1.263	-1.580*	-1.206	-1.621**	-1.232
	(0.669)	(0.831)	(0.665)	(0.863)	(0.655)	(0.848)	(0.652)	(0.863)	(0.657)	(0.868)
Sett/Ind_84			-0.260	0.019	-0.307	-0.037	0.038	0.301	-0.172	0.078
			(0.348)	(0.388)	(0.380)	(0.357)	(0.219)	(0.285)	(0.318)	(0.385)
D_K					-0.118	-0.148				
					(0.219)	(0.221)				
Owners/ha_I							0.482**	0.457**		
							(0.144)	(0.197)		
ShareOwners_I									0.407	0.322
									(0.247)	(0.338)
Constant	-1.703**	-1.162	-1.734**	-1.157	-1.701**	-1.110	-2.066***	-1.508	-1.991**	-1.382
	(0.557)	(1.003)	(0.591)	(1.087)	(0.625)	(1.142)	(0.521)	(1.077)	(0.641)	(1.183)
N	193	193	193	193	193	193	191	191	193	193
R^2	0.38	0.28	0.38	0.28	0.38	0.28	0.41	0.33	0.39	0.30
R2_A	0.35	0.25	0.35	0.24	0.35	0.24	0.38	0.29	0.35	0.26

*Significant at 10%; **significant at 5%; *** significant at 1%. Cluster-robust standard errors in parentheses. *OLS* is Ordinary Least Squares and 2SLS is Two Stage Least Square. *AverPropSize(I)* is the variable measuring land concentration. *D_Aver>500ha* is a dummy variable equal to one when if the average property in a municipality is above 500 hectares (calculated from a different source than that used for *AverPropSize(I)*). In 2SLS the *AverPropSize(I)* is instrumented with *Creation*. Dependent variable is in logarithms. *Source*: SA (1904/05, 1913/14), Busson (1898), ANOM-iREL, and GIS databases. See Appendix D for more detail on the construction of variables and sources.

Table A.7: Determinants of European agricultural population, Constantine in 1904/05 and 1913/14

Dependent variable: European agricultural population per hectare (*EurAgrPop/ha_i,t*)										
	OLS (1a)	2SLS (1b)	OLS (2a)	2SLS (2b)	OLS (3a)	2SLS (3b)	OLS (4a)	2SLS (4b)	OLS (5a)	2SLS (5b)
ShareProp>41ha	-1.468***	-2.851**	-1.443***	-2.945*	-1.454***	-2.975*	-1.427***	-2.767	-1.401***	-2.867
	(0.252)	(1.451)	(0.301)	(1.754)	(0.313)	(1.793)	(0.203)	(1.773)	(0.288)	(1.814)
ShortPthRW	-0.050	-0.038	-0.048	-0.039	-0.047	-0.037	-0.042	-0.035	-0.046	-0.038
	(0.038)	(0.033)	(0.039)	(0.035)	(0.038)	(0.034)	(0.031)	(0.025)	(0.038)	(0.035)
CropSuit	0.091	0.134	0.082	0.144	0.082	0.145	0.142	0.195*	0.078	0.140
	(0.081)	(0.098)	(0.079)	(0.116)	(0.079)	(0.117)	(0.074)	(0.113)	(0.079)	(0.119)
RoadNetwork	0.167*	0.128*	0.168*	0.125*	0.170*	0.129*	0.129**	0.093	0.171*	0.129
	(0.071)	(0.070)	(0.070)	(0.075)	(0.070)	(0.076)	(0.046)	(0.065)	(0.072)	(0.081)
DWine	-0.779	-0.972	-0.767	-0.991	-0.771	-0.999	-0.896	-1.092*	-0.717	-0.950
	(0.523)	(0.599)	(0.529)	(0.652)	(0.524)	(0.650)	(0.493)	(0.634)	(0.539)	(0.688)
DYear	-0.011	0.038	-0.012	0.041	-0.011	0.043	-0.025	0.026	-0.036	0.024
	(0.083)	(0.123)	(0.082)	(0.133)	(0.084)	(0.137)	(0.077)	(0.133)	(0.088)	(0.146)
DType	-0.297	-0.389*	-0.276	-0.410	-0.294	-0.443	-0.230	-0.350	-0.146	-0.320
	(0.183)	(0.233)	(0.185)	(0.271)	(0.203)	(0.313)	(0.164)	(0.236)	(0.223)	(0.345)
Sett/Ind_84			-0.225	0.179	-0.266	0.109	0.129	0.506	-0.124	0.232
			(0.420)	(0.577)	(0.439)	(0.517)	(0.258)	(0.450)	(0.389)	(0.558)
D_K					-0.106	-0.188				
					(0.215)	(0.296)				
Owners/ha_I							0.561***	0.546***		
							(0.112)	(0.192)		
ShareOwners_I									0.474*	0.312
									(0.236)	(0.407)
Constant	-2.185***	-1.631	-2.210***	-1.583	-2.182**	-1.528	-2.565***	-1.986*	-2.498***	-1.794
	(0.530)	(1.058)	(0.564)	(1.196)	(0.599)	(1.266)	(0.475)	(1.177)	(0.612)	(1.362)
N	193	193	193	193	193	193	191	191	193	193
R^2	0.29	0.14	0.29	0.12	0.29	0.12	0.34	0.21	0.31	0.14
R2_A	0.26	0.11	0.26	0.08	0.26	0.07	0.31	0.17	0.27	0.10

*Significant at 10%; **significant at 5%; *** significant at 1%. Cluster-robust standard errors in parentheses. *OLS* is Ordinary Least Squares and 2SLS is Two Stage Least Square. *ShareProp>41ha_E* is the variable measuring land concentration. In 2SLS the *ShareProp>41ha_E* is instrumented with *Creation*. Dependent variable is in logarithms. *Source*: SA (1904/05, 1913/14), Busson (1898), ANOM-iREL, and GIS databases. See Appendix D for more detail on the construction of variables and sources.

Appendix B

Appendix: Chapter 3

Table B.1: Summary statistics in Chapter 3

Variable	Mean	Std. Dev.	Min.	Max.	N
IndexLC_E	46.452	22.524	8.214	100	197
Creation	1867.244	15.386	1843	1916	200
ShareProp<10ha_E	0.198	0.251	0	0.929	197
ShareProp>41ha_E	0.423	0.314	0	1	197
ShareCereal_E	0.763	0.359	0	4.14	199
ShareWine_E	0.112	0.26	0	3.1	199
AreaCereal_E	2220.09	2876.014	0	17900	199
AreaWine_E	139.151	291.509	0	1898	199
LandPrice_E	180.728	313.915	3	2500	151
Wage/day_I	1.771	0.404	0.155	3	181
MachPrice_E	8918.596	4489.63	300	20000	136
Lab/day_I	0.044	0.116	0.003	1.237	184
Land/Labor	8.347	14.6	0.03	107.625	185
LabScarc_I	1.145	3.937	0	47.2	184
D_Year	0.5	0.501	0	1	200
Mach/ha_E	0.003	0.011	0	0.143	198
Tresh/ha_E	0.004	0.016	0	0.167	193
Harv/ha_E	0.004	0.006	0	0.032	194
FrPlow/ha_E	0.06	0.079	0	0.828	196
Instr/ha_E	0.178	0.19	0.011	1.69	195
Moderniz_E	0.044	0.114	-0.856	0.828	197

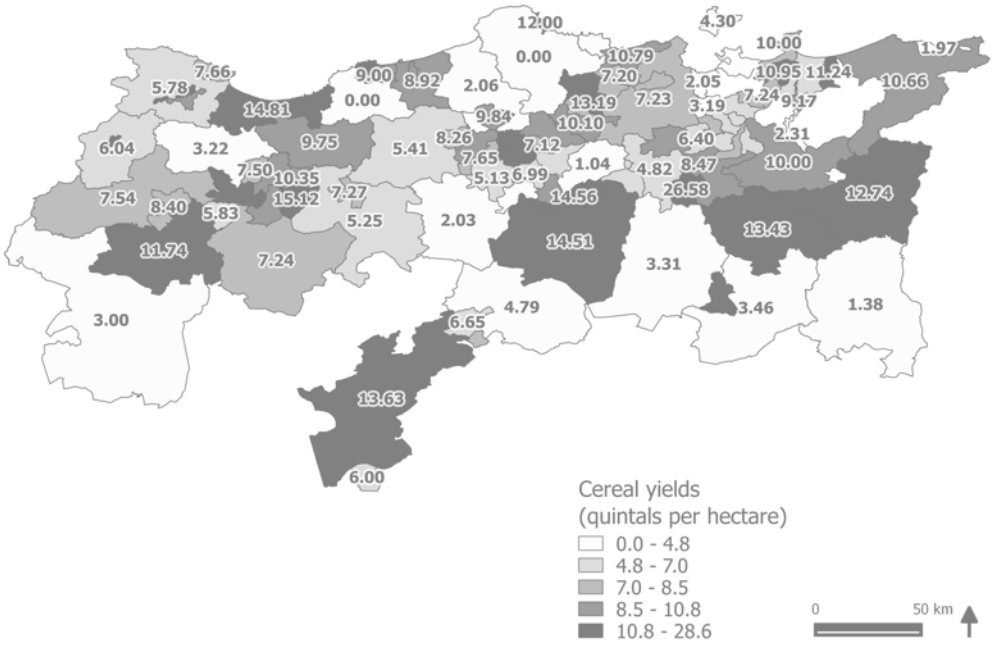
These values are for Constantine in the years 1904/05 and 1913/14. See Appendix D for detail on the construction of variables and sources.

Table B.2: Pair-wise correlation matrix in Chapter 3

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)
(1) IndexLC_E	1.00																				
(2) Creation	0.39	1.00																			
	(0.00)																				
(3) ShareProp<10ha_E	-0.75	-0.41	1.00																		
	(0.00)	(0.00)																			
(4) ShareProp>41ha_E	0.96	0.33	-0.60	1.00																	
	(0.00)	(0.00)	(0.00)																		
(5) ShareCeralArea_E	0.29	0.22	-0.28	0.23	1.00																
	(0.00)	(0.00)	(0.00)	(0.00)																	
(6) ShareWineArea_E	-0.03	0.00	0.04	-0.02	0.27	1.00															
	(0.65)	(0.97)	(0.55)	(0.79)	(0.00)																
(7) Area_Cer(ha)_E	0.25	0.23	-0.20	0.22	0.28	-0.24	1.00														
	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)															
(8) Area_Wine(ha)_E	-0.13	-0.15	0.15	-0.10	-0.32	0.31	-0.05	1.00													
	(0.07)	(0.04)	(0.04)	(0.17)	(0.00)	(0.00)	(0.51)														
(9) LandPrice_E	-0.19	-0.22	0.35	-0.15	-0.13	0.02	-0.02	0.18	1.00												
	(0.02)	(0.01)	(0.00)	(0.08)	(0.10)	(0.81)	(0.82)	(0.03)													
(10) Wage/day_I	-0.08	-0.22	0.12	-0.11	0.06	-0.06	0.07	-0.06	0.12	1.00											
	(0.29)	(0.00)	(0.10)	(0.16)	(0.43)	(0.39)	(0.38)	(0.46)	(0.15)												
(11) Mach/ha_E	0.22	0.17	-0.28	0.15	0.23	-0.15	0.33	-0.16	-0.08	0.05	1.00										
	(0.01)	(0.05)	(0.00)	(0.09)	(0.01)	(0.07)	(0.00)	(0.06)	(0.46)	(0.55)											
(12) L/day_I	-0.03	0.09	-0.01	-0.04	0.03	-0.04	0.06	-0.07	0.06	-0.11	-0.03	1.00									
	(0.74)	(0.24)	(0.94)	(0.64)	(0.72)	(0.60)	(0.44)	(0.37)	(0.49)	(0.15)	(0.76)										
(13) Land/Labour	0.01	-0.19	-0.05	-0.02	-0.00	-0.09	0.14	0.10	0.03	0.05	0.14	-0.07	1.00								
	(0.94)	(0.01)	(0.46)	(0.78)	(1.00)	(0.20)	(0.07)	(0.17)	(0.73)	(0.55)	(0.11)	(0.37)									
(14)LabScarc_I	-0.13	-0.19	0.10	-0.11	-0.18	0.20	-0.12	0.45	0.07	0.02	0.05	0.04	0.29	1.00							
	(0.09)	(0.01)	(0.19)	(0.13)	(0.02)	(0.01)	(0.11)	(0.00)	(0.39)	(0.74)	(0.55)	(0.55)	(0.00)								
(15) DYear	0.05	0.00	-0.02	0.05	0.02	-0.12	0.11	-0.04	0.03	0.20	0.05	-0.13	0.03	-0.01	1.00						
	(0.52)	(1.00)	(0.81)	(0.46)	(0.79)	(0.10)	(0.12)	(0.53)	(0.70)	(0.01)	(0.58)	(0.09)	(0.73)	(0.92)							
(16) Mac/ha_E	-0.18	-0.17	0.28	-0.14	-0.16	-0.01	-0.08	0.04	0.58	0.15	-0.16	-0.05	-0.03	-0.03	0.09	1.00					
	(0.01)	(0.02)	(0.00)	(0.05)	(0.02)	(0.94)	(0.29)	(0.58)	(0.00)	(0.05)	(0.06)	(0.50)	(0.69)	(0.69)	(0.20)						
(17) Tresh/ha_E	-0.22	-0.21	0.30	-0.16	-0.34	0.18	-0.12	-0.01	0.07	0.00	-0.08	0.02	-0.08	0.06	-0.04	0.12	1.00				
	(0.00)	(0.00)	(0.00)	(0.03)	(0.00)	(0.01)	(0.10)	(0.88)	(0.38)	(1.00)	(0.35)	(0.78)	(0.31)	(0.46)	(0.61)	(0.11)					
(18) Harv/ha_E	-0.08	-0.27	0.09	-0.06	-0.08	0.05	0.00	0.19	0.23	0.08	-0.02	-0.09	0.09	0.16	0.08	0.26	0.02	1.00			
	(0.26)	(0.00)	(0.20)	(0.42)	(0.24)	(0.48)	(0.97)	(0.01)	(0.01)	(0.30)	(0.82)	(0.23)	(0.24)	(0.03)	(0.30)	(0.00)	(0.74)				
(19) FrPlow/ha_E	-0.14	-0.14	0.18	-0.11	0.27	0.75	-0.24	0.17	0.28	0.06	-0.17	-0.08	-0.11	0.08	-0.02	0.35	0.10	0.14	1.00		
	(0.06)	(0.05)	(0.01)	(0.13)	(0.00)	(0.00)	(0.00)	(0.02)	(0.00)	(0.46)	(0.04)	(0.30)	(0.15)	(0.26)	(0.83)	(0.00)	(0.16)	(0.05)			
(20) Instr/ha_E	-0.22	-0.12	0.23	-0.19	0.18	0.64	-0.22	0.11	0.38	0.02	-0.21	0.19	-0.14	0.06	-0.02	0.36	0.13	0.17	0.85	1.00	
	(0.00)	(0.10)	(0.00)	(0.01)	(0.01)	(0.00)	(0.00)	(0.12)	(0.00)	(0.78)	(0.02)	(0.01)	(0.06)	(0.39)	(0.76)	(0.00)	(0.08)	(0.02)	(0.00)		
(21) Moderniz_E	-0.05	-0.16	0.15	-0.01	0.15	0.55	-0.23	0.14	0.27	0.09	-0.03	-0.46	-0.03	0.08	0.00	0.24	0.08	0.09	0.74	0.36	1.00
	(0.46)	(0.02)	(0.04)	(0.84)	(0.03)	(0.00)	(0.00)	(0.04)	(0.00)	(0.21)	(0.69)	(0.00)	(0.73)	(0.30)	(0.97)	(0.00)	(0.29)	(0.21)	(0.00)	(0.00)	

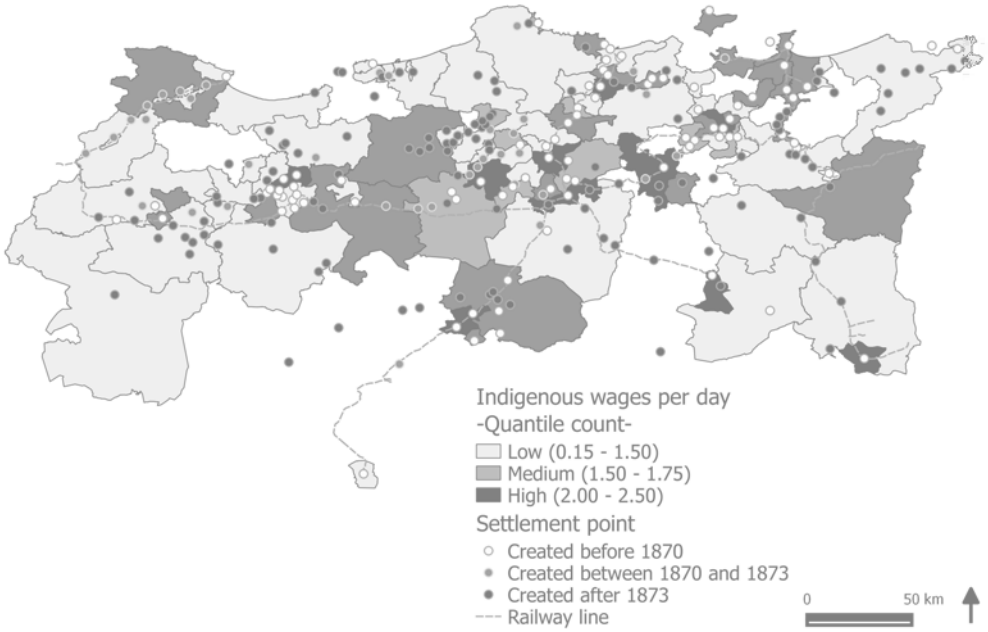
Standard deviation in parenthesis. See Appendix D for more detail on the construction of variables and sources.

Figure B.1: Winter cereal yields (quintals per hectare), Constantine in 1904/05 and 1913/14



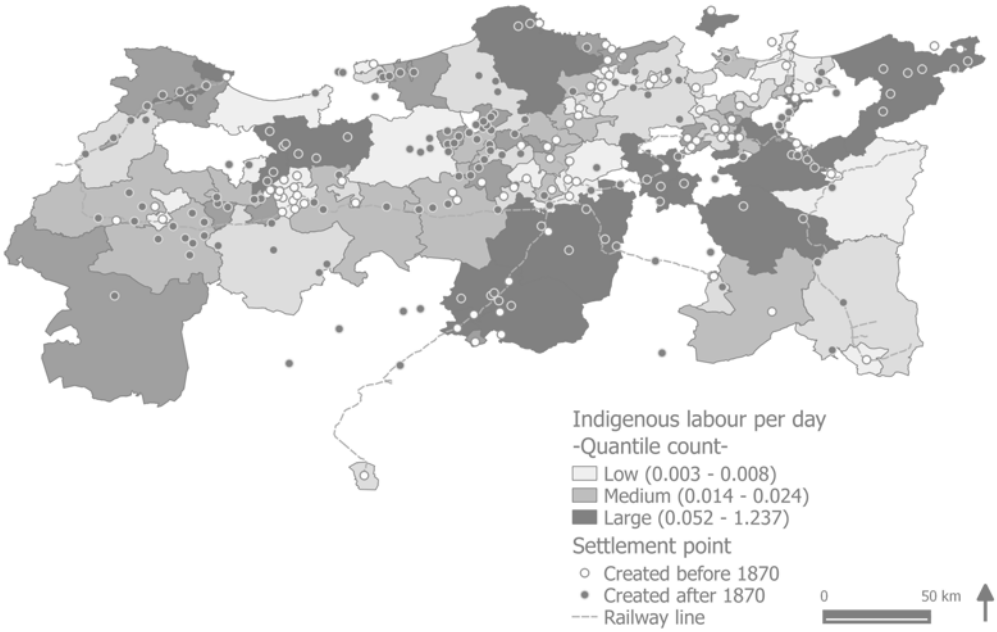
Winter cereal yields include soft wheat, hard wheat, rye, barley, and oats covering the cultivated area corresponding to the 1904/05 agricultural season. The data is classified according to quantiles (equal count). *Source*: SA (1904/05, 1913/14), Busson (1898), ANOM-iREL. See Appendix D for more detail on the construction of variables and sources.

Figure B.2: Indigenous wages per day, Constantine in 1904/05



The data is classified according to quantiles (equal count). *Source*: SA (1904/05, 1913/14), Busson (1898), ANOM-iREL. See Appendix D for more detail on the construction of variables and sources.

Figure B.3: Indigenous labor per day, Constantine in 1904/05 and 1913/14



The data is classified according to quantiles (equal count). *Source*: SA (1904/05, 1913/14), Busson (1898), ANOM-iREL. See Appendix D for more detail on the construction of variables and sources.

Appendix C

Appendix: Chapter 4

Table C.1: Summary statistics in Chapter 4

Variable	Mean	Std. Dev.	Min.	Max.	N
Settler density	0.03	0.18	0	2.71	768
Indigenous density	0.35	0.47	0	5.89	768
Dummy< 10km	0.14	0.35	0	1	768
Dummy< 20km	0.25	0.43	0	1	768
Elevation	602.6	412.1	0	1,638	768
Instrumental variable	0.11	0.31	0	1	768

These values are for Constantine in the years 1904/05 and 1913/14 (full sample). See Appendix D for detail on the construction of variables and sources.

Table C.2: Pair-wise correlation matrix in Chapter 4

Variables	Settden	Indden	D< 10km	D< 20km	Elev	IV
Settler density	1.00					
Indigenous density	0.68	1.00				
	(0.00)					
Dummy< 10km	0.01	0.05	1.00			
	(0.70)	(0.15)				
Dummy< 20km	-0.02	0.02	0.71	1.00		
	(0.54)	(0.62)	(0.00)			
Elevation	-0.13	-0.20	0.11	0.20	1.00	
	(0.00)	(0.00)	(0.00)	(0.00)		
Instrumental variable	0.12	0.07	0.73	0.54	0.10	1.00
	(0.00)	(0.05)	(0.00)	(0.00)	(0.01)	

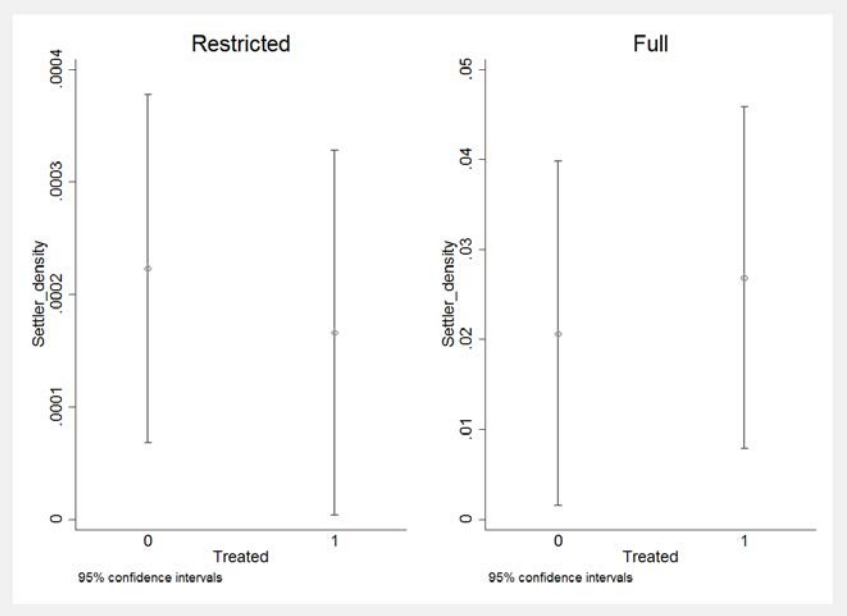
These values are for Constantine in the years 1904/05 and 1913/14 (full sample). Standard deviation in parentheses. See Appendix D for detail on the construction of variables and sources.

Table C.3: Summary statistics of *elevation* and t-test mean difference between treated and control groups

	Restricted sample				Full Sample			
	<20 km		<10 km		<20 km		<10 km	
	N	Mean	N	Mean	N	Mean	N	Mean
Control	157	566.52	183	597.20	192	554.09	219	583.71
		(32.89)		(29.99)		(29.49)		(27.37)
Treated	49	800.84	23	821.61	64	748.20	37	714.54
		(57.27)		(102.18)		(49.10)		(73.06)
Mean Difference		-234.32		-224.41		-194.11		-130.83
		(66.05)***		(106.49)**		(57.28)***		(-130.83)*

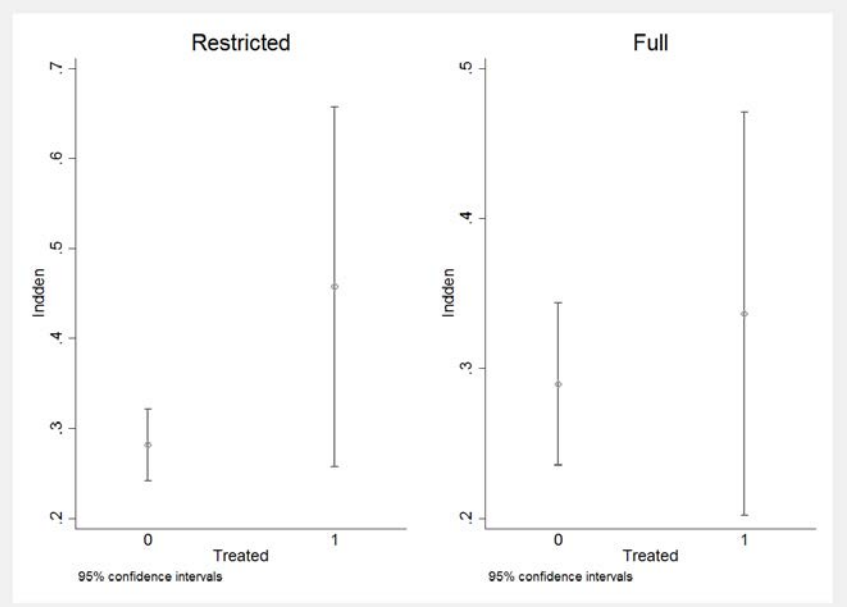
*Significant at 10%; **significant at 5%; *** significant at 1%. Standard errors in parenthesis. The unit of observation are the sub-municipal areas such as settlement centers and *douars*. Results are shown for unequal variances although significance level is robust under equal variance assumption. *Source*: CGIAR Shuttle Radar Topography Mission 3 from California Institute of Technology.

Figure C.1: Mean and confidence intervals of settler population density (by treated and control groups) in year 1884



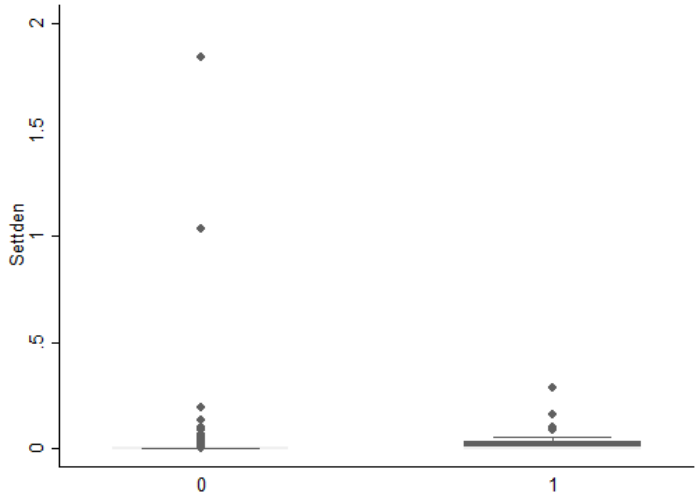
Source: Tableau Général des Communes (1884).

Figure C.2: Mean and confidence intervals of indigenous population density (by treated and control groups) in year 1884



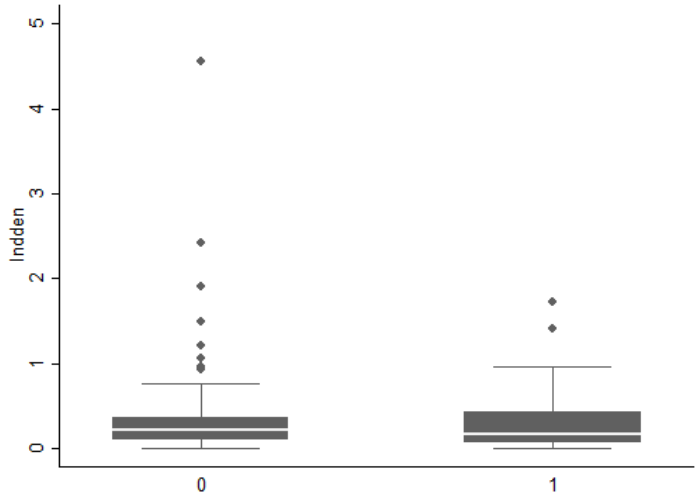
Source: Tableau Général des Communes (1884).

Figure C.3: Box plot of settler population density (by treated and control groups) in year 1884



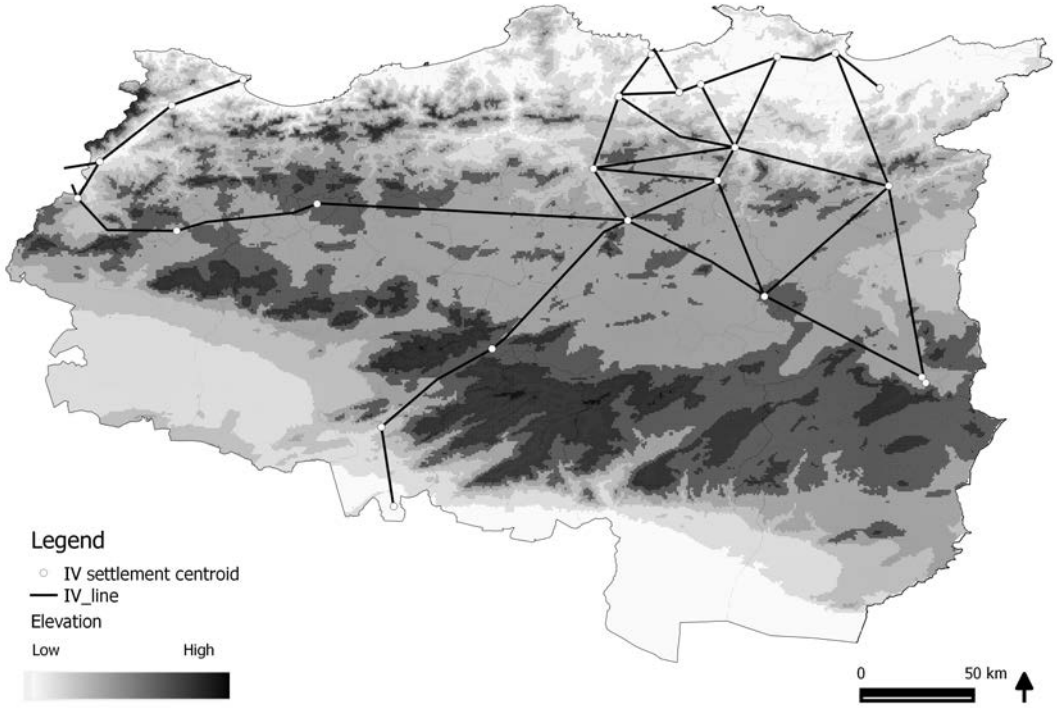
X-axis: control group is labeled 0 and treated group is 1. *Source*: TGdC (1884).

Figure C.4: Box plot of indigenous population density (by treated and control groups) in year 1884



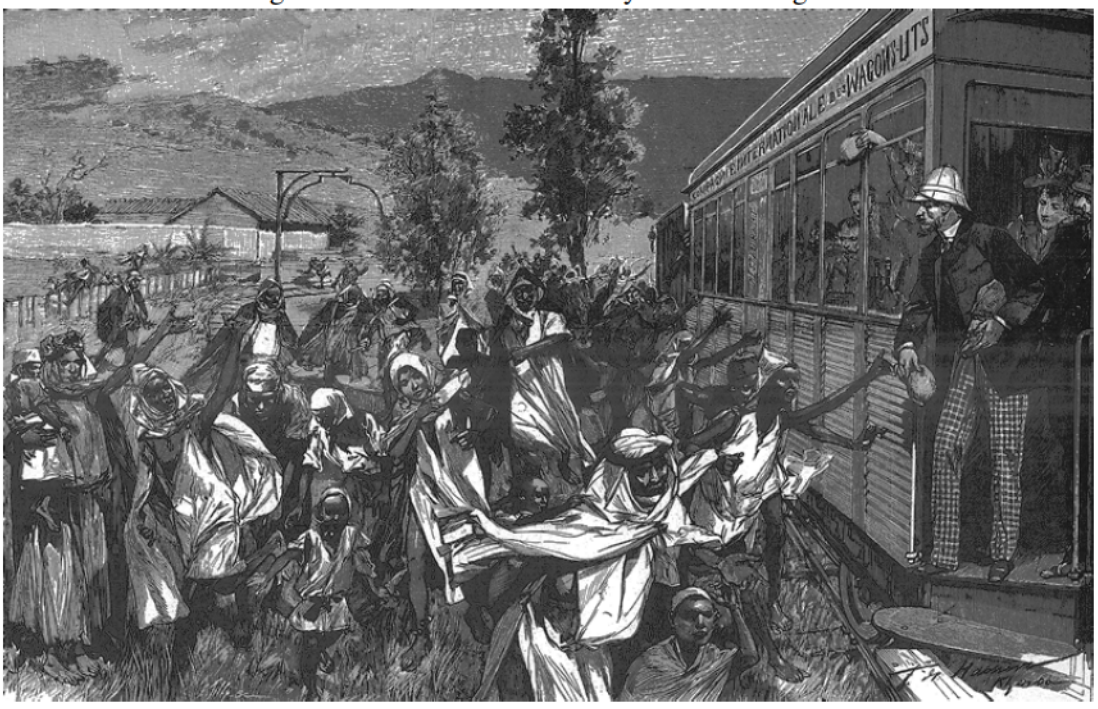
X-axis: control group is labeled 0 and treated group is 1. *Source*: TGdC (1884).

Figure C.5: Map of railway instrumental lines in Constantine



Source: For detail on sources and construction of instrumental variable see the methodology section in Chapter 4.

Figure C.6: Picture of the railway in French Algeria



Source: Harter (2005, p. 243)

Table C.4: Diff-in-diff regressions: effects of railway access on **settler** population density, Constantine 1884-1892

	Dependent variable: settler population density																	
	Restricted						Full Sample											
	<20km			<10km			<20km						<10km					
	No Termini						Termini			No Termini			Termini			No Termini		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
VARIABLES	No Cov.	Matched	C.Supp.	No Cov.	Matched	C.Supp.	No Cov.	Matched	C.Supp.	No Cov.	Matched	C.Supp.	No Cov.	Matched	C.Supp.	No Cov.	Matched	C.Supp.
β_3 (diff-in-diff)	-0.859	-0.584	-0.613	-0.858	-0.691	-0.721	-0.007	-0.003	-0.003	-0.006	-0.003	-0.003	-0.006	-0.004	-0.004	-0.005	-0.004	-0.004
	(0.712)	(0.481)	(0.487)	(0.614)	(0.487)	(0.480)	(0.005)	(0.003)	(0.003)	(0.004)	(0.002)	(0.002)	(0.005)	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)
Observations	412	412	410	412	412	406	512	512	504	504	504	502	512	512	504	504	504	496
R-squared	0.011	0.011	0.011	0.008	0.011	0.012	0.001	0.000	0.001	0.001	0.000	0.000	0.001	0.002	0.003	0.000	0.000	0.001
Covariates	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
PS	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mean control t0	0.243	0.268	0.256	0.223	0.254	0.250	0.0232	0.0141	0.0134	0.0179	0.0113	0.0115	0.0206	0.0169	0.0163	0.0160	0.0133	0.0127
Mean treated t0	0.130	0.130	0.133	0.166	0.166	0.182	0.0165	0.0165	0.0171	0.0109	0.0109	0.0111	0.0268	0.0268	0.0284	0.0176	0.0176	0.0187
Diff t0	-0.113	-0.138	-0.123	-0.0570	-0.0883	-0.0684	-0.00662	0.00248	0.00365	-0.00698	-0.000387	-0.000383	0.00622	0.00992	0.0120	0.00164	0.00433	0.00602
Mean control t1	1.086	0.836	0.853	0.957	0.822	0.836	0.0329	0.0198	0.0189	0.0240	0.0150	0.0153	0.0292	0.0240	0.0231	0.0214	0.0178	0.0170
Mean treated t1	0.115	0.115	0.117	0.0423	0.0423	0.0463	0.0188	0.0188	0.0194	0.0114	0.0114	0.0116	0.0300	0.0300	0.0317	0.0177	0.0177	0.0188
Diff t1	-0.972	-0.721	-0.736	-0.915	-0.779	-0.790	-0.0140	-0.000978	0.000510	-0.0125	-0.00361	-0.00367	0.000715	0.00600	0.00854	-0.00373	-9.05e-05	0.00185

Table C.5: Diff-in-diff regressions: effects of railway access on **indigenous** population density, Constantine 1884-1892

	Dependent variable: indigenous population density																	
	Restricted						Full Sample											
	<20km			<10km			<20km						<10km					
	No Termini						Termini			No Termini			Termini			No Termini		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
VARIABLES	No Cov.	Matched	C.Supp.	No Cov.	Matched	C.Supp.	No Cov.	Matched	C.Supp.	No Cov.	Matched	C.Supp.	No Cov.	Matched	C.Supp.	No Cov.	Matched	C.Supp.
β_3 (diff-in-diff)	0.030	0.028	0.029	0.047	0.046	0.054	0.017	0.023	0.026	0.024	0.028	0.029	0.022	0.026	0.030	0.033	0.036	0.041
	(0.029)	(0.027)	(0.028)	(0.036)	(0.035)	(0.038)	(0.025)	(0.023)	(0.023)	(0.025)	(0.023)	(0.023)	(0.025)	(0.024)	(0.025)	(0.025)	(0.024)	(0.025)
Observations	412	412	410	412	412	406	512	512	504	504	504	502	512	512	504	504	504	496
R-squared	0.022	0.032	0.030	0.049	0.083	0.061	0.006	0.012	0.011	0.007	0.014	0.013	0.008	0.015	0.011	0.009	0.018	0.013
Covariates	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
PS	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mean control t0	0.286	0.258	0.256	0.281	0.261	0.259	0.295	0.263	0.260	0.287	0.258	0.258	0.289	0.277	0.275	0.282	0.270	0.268
Mean treated t0	0.347	0.347	0.340	0.457	0.457	0.401	0.298	0.298	0.273	0.295	0.295	0.289	0.336	0.336	0.295	0.336	0.336	0.291
Diff t0	0.0607	0.0891	0.0841	0.176	0.196	0.141	0.00218	0.0347	0.0135	0.00841	0.0374	0.0311	0.0469	0.0593	0.0205	0.0538	0.0652	0.0225
Mean control t1	0.350	0.324	0.321	0.347	0.328	0.325	0.361	0.323	0.318	0.350	0.317	0.316	0.356	0.340	0.336	0.346	0.332	0.328
Mean treated t1	0.441	0.441	0.434	0.570	0.570	0.520	0.380	0.380	0.357	0.382	0.382	0.376	0.425	0.425	0.387	0.433	0.433	0.392
Diff t1	0.0908	0.117	0.113	0.223	0.241	0.195	0.0194	0.0577	0.0393	0.0326	0.0656	0.0597	0.0690	0.0850	0.0509	0.0866	0.101	0.0634

Tables C.4 and C.5: *** p<0.01, ** p<0.05, * p<0.1. Cluster-robust standard errors in parentheses. Covariate is *elevation*. PS is Kernel-based propensity score matching diff-in-Diff and the PS is regressed on *elev*. The balancing property is always satisfied. Column *C.Supp.* satisfies the common support condition required for matching. The settler population in the restricted sample is per thousand. *Sources*: TGdC (1884), TGdC (1892), and TGdC (1897). See Appendix D for detail on sources.

Table C.6: Diff-in-diff regressions: effects of railway access on **settler** population density, Constantine 1884-1897

	Dependent variable: settler population density																	
	Restricted						Full Sample											
	<20km			<10km			<20km						<10km					
	No Termini						Termini			No Termini			Termini			No Termini		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
VARIABLES	No Cov.	Matched	C.Supp.	No Cov.	Matched	C.Supp.	No Cov.	Matched	C.Supp.	No Cov.	Matched	C.Supp.	No Cov.	Matched	C.Supp.	No Cov.	Matched	C.Supp.
β_3 (diff-in-diff)	-0.379	-0.092	-0.111	-0.009	0.158	0.232	-0.001	0.004	0.005	-0.000	0.003	0.003	0.008	0.010	0.012	0.006	0.007	0.008
	(0.625)	(0.473)	(0.482)	(0.685)	(0.622)	(0.667)	(0.009)	(0.007)	(0.007)	(0.007)	(0.006)	(0.006)	(0.011)	(0.011)	(0.011)	(0.010)	(0.010)	(0.010)
Observations	412	412	410	412	412	406	512	512	504	504	504	502	512	512	504	504	504	496
R-squared	0.019	0.019	0.020	0.017	0.025	0.028	0.001	0.002	0.003	0.001	0.001	0.001	0.002	0.007	0.008	0.001	0.003	0.004
Covariates	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
PS	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mean control t0	0.243	0.268	0.256	0.223	0.254	0.250	0.0232	0.0141	0.0134	0.0179	0.0113	0.0115	0.0206	0.0169	0.0163	0.0160	0.0133	0.0127
Mean treated t0	0.130	0.130	0.133	0.166	0.166	0.182	0.0165	0.0165	0.0171	0.0109	0.0109	0.0111	0.0268	0.0268	0.0284	0.0176	0.0176	0.0187
Diff t0	-0.113	-0.138	-0.123	-0.0570	-0.0883	-0.0684	-0.00662	0.00248	0.00365	-0.00698	-0.000387	-0.000383	0.00622	0.00992	0.0120	0.00164	0.00433	0.00602
Mean control t1	1.261	0.999	1.019	1.152	1.016	1.025	0.0356	0.0214	0.0205	0.0256	0.0160	0.0163	0.0317	0.0259	0.0251	0.0229	0.0190	0.0181
Mean treated t1	0.769	0.769	0.785	1.085	1.085	1.189	0.0283	0.0283	0.0292	0.0185	0.0185	0.0188	0.0463	0.0463	0.0489	0.0304	0.0304	0.0323
Diff t1	-0.492	-0.230	-0.234	-0.0662	0.0696	0.164	-0.00733	0.00685	0.00869	-0.00709	0.00245	0.00250	0.0146	0.0204	0.0239	0.00749	0.0114	0.0142

Table C.7: Diff-in-diff regressions: effects of railway access on **indigenous** population density, Constantine 1884-1897

	Dependent variable: indigenous population density																	
	Restricted						Full Sample											
	<20km			<10km			<20km						<10km					
	No Termini						Termini			No Termini			Termini			No Termini		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
VARIABLES	No Cov.	Matched	C.Supp.	No Cov.	Matched	C.Supp.	No Cov.	Matched	C.Supp.	No Cov.	Matched	C.Supp.	No Cov.	Matched	C.Supp.	No Cov.	Matched	C.Supp.
β_3 (diff-in-diff)	0.045	0.042	0.042	0.070	0.068	0.077	0.035	0.040	0.043	0.034	0.037	0.037	0.046	0.050*	0.054*	0.042	0.044	0.048
	(0.043)	(0.042)	(0.042)	(0.046)	(0.046)	(0.048)	(0.033)	(0.031)	(0.031)	(0.033)	(0.032)	(0.032)	(0.029)	(0.028)	(0.028)	(0.030)	(0.030)	(0.030)
Observations	412	412	410	412	412	406	512	512	504	504	504	502	512	512	504	504	504	496
R-squared	0.032	0.041	0.039	0.060	0.092	0.071	0.011	0.021	0.019	0.011	0.020	0.019	0.014	0.025	0.021	0.014	0.024	0.019
Covariates	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
PS	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mean control t0	0.286	0.258	0.256	0.281	0.261	0.259	0.295	0.263	0.260	0.287	0.258	0.258	0.289	0.277	0.275	0.282	0.270	0.268
Mean treated t0	0.347	0.347	0.340	0.457	0.457	0.401	0.298	0.298	0.273	0.295	0.295	0.289	0.336	0.336	0.295	0.336	0.336	0.291
Diff t0	0.0607	0.0891	0.0841	0.176	0.196	0.141	0.00218	0.0347	0.0135	0.00841	0.0374	0.0311	0.0469	0.0593	0.0205	0.0538	0.0652	0.0225
Mean control t1	0.372	0.347	0.344	0.370	0.352	0.348	0.382	0.345	0.340	0.370	0.338	0.337	0.378	0.362	0.358	0.367	0.353	0.350
Mean treated t1	0.478	0.478	0.470	0.616	0.616	0.566	0.420	0.420	0.396	0.412	0.412	0.405	0.471	0.471	0.433	0.463	0.463	0.420
Diff t1	0.106	0.131	0.126	0.246	0.264	0.218	0.0371	0.0747	0.0562	0.0422	0.0740	0.0676	0.0930	0.109	0.0746	0.0954	0.110	0.0707

Tables C.4 and C.5: *** p<0.01, ** p<0.05, * p<0.1. Cluster-robust standard errors in parentheses. Covariate is *elevation*. PS is Kernel-based pPropensity score matching diff-in-diff and the PS is regressed on *elev*. The balancing property is always satisfied. Column *C.Supp.* satisfies the common support condition required for matching. The settler population in the restricted sample is per thousand. *Sources*: TGdC (1884, 1892, and 1897); see Appendix D for more detail on sources.

Table C.8: Diff-in-diff regressions: effects of railway access on **settler** population density (*indden*<2), Constantine 1884-1892

	Dependent variable: settler population density																	
	Restricted						Full Sample											
	<20km			<10km			<20km						<10km					
	No Termini						Termini			No Termini			Termini			No Termini		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
VARIABLES	No Cov.	Matched	C.Supp.	No Cov.	Matched	C.Supp.	No Cov.	Matched	C.Supp.	No Cov.	Matched	C.Supp.	No Cov.	Matched	C.Supp.	No Cov.	Matched	C.Supp.
β_3 (diff-in-diff)	-0.862	-0.585	-0.608	-0.860	-0.693	-0.732	4.968	3.467	3.598	-2.270	-1.607	-1.636	5.936	5.388	5.867	-2.123	-1.880	-1.569
	(0.717)	(0.485)	(0.487)	(0.617)	(0.491)	(0.504)	(5.753)	(3.670)	(3.675)	(1.474)	(1.284)	(1.306)	(5.461)	(4.753)	(4.960)	(1.508)	(1.445)	(1.512)
Observations	409	409	407	409	409	407	506	506	498	499	499	497	506	506	498	499	499	487
R-squared	0.011	0.011	0.011	0.008	0.011	0.012	0.002	0.008	0.010	0.002	0.005	0.005	0.012	0.027	0.033	0.013	0.025	0.038
Covariates	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
PS	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mean control t0	0.245	0.269	0.255	0.224	0.255	0.242	13.69	9.975	9.578	8.299	6.859	6.946	12.29	10.90	10.44	7.567	7.072	6.647
Mean treated t0	0.130	0.130	0.133	0.166	0.166	0.173	16.54	16.54	17.07	10.89	10.89	11.07	26.82	26.82	28.35	17.59	17.59	19.28
Diff t0	-0.115	-0.139	-0.122	-0.0582	-0.0893	-0.0691	2.841	6.560	7.491	2.588	4.028	4.123	14.52	15.92	17.91	10.03	10.52	12.63
Mean control t1	1.093	0.840	0.850	0.963	0.827	0.847	11.30	9.085	8.649	11.30	9.200	9.330	10.33	9.486	8.830	10.33	9.594	8.998
Mean treated t1	0.117	0.117	0.119	0.0442	0.0442	0.0463	19.11	19.11	19.74	11.62	11.62	11.82	30.79	30.79	32.60	18.23	18.23	20.06
Diff t1	-0.976	-0.723	-0.730	-0.918	-0.783	-0.801	7.809	10.03	11.09	0.318	2.421	2.487	20.46	21.31	23.77	7.902	8.640	11.06

Table C.9: Diff-in-diff regressions: effects of railway access on **indigenous** population density (*indden*<2), Constantine 1884-1892

	Dependent variable: indigenous population density																	
	Restricted						Full Sample											
	<20km			<10km			<20km						<10km					
	No Termini						Termini			No Termini			Termini			No Termini		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
VARIABLES	No Cov.	Matched	C.Supp.	No Cov.	Matched	C.Supp.	No Cov.	Matched	C.Supp.	No Cov.	Matched	C.Supp.	No Cov.	Matched	C.Supp.	No Cov.	Matched	C.Supp.
β_3 (diff-in-diff)	-0.006	-0.007	-0.007	-0.022	-0.023	-0.025	0.006	0.004	0.005	0.001	0.002	0.001	-0.009	-0.009	-0.008	-0.012	-0.011	-0.009
	(0.036)	(0.035)	(0.035)	(0.078)	(0.077)	(0.080)	(0.029)	(0.028)	(0.028)	(0.029)	(0.028)	(0.028)	(0.049)	(0.049)	(0.052)	(0.053)	(0.052)	(0.057)
Observations	409	409	407	409	409	407	506	506	498	499	499	497	506	506	498	499	499	487
R-squared	0.024	0.030	0.028	0.050	0.076	0.066	0.012	0.016	0.012	0.016	0.018	0.016	0.016	0.020	0.011	0.020	0.023	0.013
Covariates	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
PS	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mean control t0	0.273	0.248	0.245	0.269	0.251	0.252	0.262	0.241	0.239	0.253	0.237	0.236	0.260	0.251	0.250	0.252	0.245	0.244
Mean treated t0	0.347	0.347	0.340	0.457	0.457	0.446	0.298	0.298	0.273	0.295	0.295	0.289	0.336	0.336	0.295	0.336	0.336	0.297
Diff t0	0.0745	0.0994	0.0946	0.188	0.206	0.194	0.0358	0.0562	0.0346	0.0423	0.0588	0.0527	0.0765	0.0847	0.0458	0.0835	0.0910	0.0529
Mean control t1	0.339	0.315	0.312	0.337	0.320	0.321	0.312	0.294	0.290	0.312	0.295	0.294	0.313	0.304	0.301	0.313	0.304	0.302
Mean treated t1	0.408	0.408	0.400	0.503	0.503	0.489	0.354	0.354	0.330	0.355	0.355	0.348	0.380	0.380	0.338	0.384	0.384	0.346
Diff t1	0.0685	0.0921	0.0871	0.165	0.182	0.169	0.0421	0.0600	0.0397	0.0431	0.0604	0.0540	0.0670	0.0755	0.0374	0.0712	0.0803	0.0437

Tables C.4 and C.5: *** p<0.01, ** p<0.05, * p<0.1. Cluster-robust standard errors in parentheses. Covariate is *elevation*. PS is Kernel-based propensity score matching differences-in-differences and the PS is regressed on *elev*. The balancing property is always satisfied. Column *C.Supp.* satisfies the common support condition required for matching. The settler population in the restricted sample is per thousand. *Sources*: TGdC (1884, 1892, and 1897); see Appendix D for detail on sources.

Table C.10: Diff-in-diff regressions: effects of railway access on **settler** population density (*indden*<2), Constantine 1884-1897

	Dependent variable: settler population density																	
	Restricted						Full Sample											
	<20km			<10km			<20km						<10km					
	No Termini						Term.			No Term.			Term.			No Term.		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
VARIABLES	No Cov.	Matched	C.Supp.	No Cov.	Matched	C.Supp.	No Cov.	Matched	C.Supp.	No Cov.	Matched	C.Supp.	No Cov.	Matched	C.Supp.	No Cov.	Matched	C.Supp.
β_3 (diff-in-diff)	-0.429	-0.139	-0.151	0.048	0.213	0.243	0.015*	0.013*	0.014*	0.005	0.005	0.006	0.022*	0.022*	0.023*	0.011	0.011	0.011
	(0.639)	(0.488)	(0.493)	(0.687)	(0.623)	(0.667)	(0.008)	(0.007)	(0.007)	(0.006)	(0.006)	(0.006)	(0.012)	(0.011)	(0.012)	(0.010)	(0.010)	(0.010)
Observations	408	408	406	408	408	402	505	505	493	498	498	496	505	505	499	498	498	496
R-squared	0.019	0.018	0.019	0.017	0.026	0.031	0.007	0.017	0.020	0.008	0.012	0.012	0.024	0.042	0.045	0.026	0.032	0.033
Covariates	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
PS	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mean control t0	0.245	0.269	0.254	0.224	0.255	0.229	0.0137	0.00997	0.00971	0.00830	0.00686	0.00693	0.0123	0.0109	0.0115	0.00757	0.00707	0.00724
Mean treated t0	0.130	0.130	0.133	0.166	0.166	0.154	0.0165	0.0165	0.0173	0.0109	0.0109	0.0111	0.0268	0.0268	0.0283	0.0176	0.0176	0.0181
Diff t0	-0.115	-0.139	-0.121	-0.0582	-0.0893	-0.0757	0.00284	0.00656	0.00763	0.00259	0.00403	0.00414	0.0145	0.0159	0.0169	0.0100	0.0105	0.0109
Mean control t1	1.269	1.004	1.013	1.145	1.011	1.081	0.0116	0.00946	0.00916	0.0116	0.00956	0.00968	0.0106	0.00978	0.0102	0.0106	0.00988	0.0101
Mean treated t1	0.726	0.726	0.741	1.135	1.135	1.248	0.0291	0.0291	0.0306	0.0191	0.0191	0.0194	0.0476	0.0476	0.0504	0.0313	0.0313	0.0323
Diff t1	-0.544	-0.278	-0.272	-0.00989	0.123	0.167	0.0176	0.0197	0.0215	0.00752	0.00950	0.00972	0.0370	0.0378	0.0402	0.0207	0.0214	0.0221

Table C.11: Diff-in-diff regressions: effects of railway access on **indigenous** population density (*indden*<2), Constantine 1884-1897

	Dependent variable: indigenous population density																	
	Restricted						Full Sample											
	<20km			<10km			<20km						<10km					
	No Termini						Term.			No Term.			Term.			No Term.		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
VARIABLES	No Cov.	Matched	C.Supp.	No Cov.	Matched	C.Supp.	No Cov.	Matched	C.Supp.	No Cov.	Matched	C.Supp.	No Cov.	Matched	C.Supp.	No Cov.	Matched	C.Supp.
β_3 (diff-in-diff)	-0.032	-0.035	-0.036	-0.000	-0.004	-0.003	-0.006	-0.010	-0.009	-0.023	-0.024	-0.025	0.018	0.017	0.017	-0.003	-0.002	-0.005
	(0.051)	(0.050)	(0.050)	(0.069)	(0.069)	(0.072)	(0.045)	(0.043)	(0.045)	(0.046)	(0.045)	(0.044)	(0.049)	(0.049)	(0.050)	(0.053)	(0.053)	(0.052)
Observations	408	408	406	408	408	402	505	505	493	498	498	496	505	505	499	498	498	496
R-squared	0.029	0.030	0.027	0.063	0.086	0.087	0.017	0.019	0.016	0.020	0.018	0.016	0.026	0.031	0.028	0.028	0.028	0.023
Covariates	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
PS	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mean control t0	0.273	0.248	0.245	0.269	0.251	0.251	0.262	0.241	0.238	0.253	0.237	0.236	0.260	0.251	0.254	0.252	0.245	0.247
Mean treated t0	0.347	0.347	0.340	0.457	0.457	0.463	0.298	0.298	0.276	0.295	0.295	0.289	0.336	0.336	0.333	0.336	0.336	0.325
Diff t0	0.0745	0.0994	0.0946	0.188	0.206	0.212	0.0358	0.0562	0.0386	0.0423	0.0588	0.0527	0.0765	0.0847	0.0785	0.0835	0.0910	0.0777
Mean control t1	0.361	0.339	0.335	0.350	0.336	0.332	0.332	0.315	0.309	0.332	0.316	0.315	0.326	0.318	0.319	0.326	0.317	0.319
Mean treated t1	0.404	0.404	0.393	0.538	0.538	0.540	0.361	0.361	0.338	0.351	0.351	0.342	0.420	0.420	0.414	0.406	0.406	0.392
Diff t1	0.0427	0.0647	0.0583	0.187	0.201	0.208	0.0294	0.0460	0.0293	0.0189	0.0349	0.0273	0.0940	0.102	0.0958	0.0805	0.0891	0.0727

Tables C.4 and C.5: *** p<0.01, ** p<0.05, * p<0.1. Cluster-robust standard errors in parentheses. Covariate is *elevation*. PS is Kernel-based propensity score matching differences-in-differences and the PS is regressed on *elev*. The balancing property is always satisfied. Column *C.Supp.* satisfies the common support condition required for matching. The settler population in the restricted sample is per thousand. *Sources*: TGdC (1884, 1892, and 1897); see Appendix D for detail on sources.

Table C.12: Diff-in-diff (IV) regressions: effects of railway access on **settler** and **indigenous** population density, Constantine 1884-1892

	Dependent: settler population density									Dependent: indigenous population density								
	Restricted			Full						Restricted			Full					
	No Termini			Termini			No Termini			No termini			Termini			No Termini		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
VARIABLES	No Cov.	Matched	C.Supp.	No Cov.	Matched	C.Supp.	No Cov.	Matched	C.Supp.	No Cov.	Matched	C.Supp.	No Cov.	Matched	C.Supp.	No Cov.	Matched	C.Supp.
β_3 (diff-in-diff)	-0.903	-0.620	-0.948	0.023	0.024	0.000	-0.005	-0.004	-0.002	0.042	0.042*	0.056**	0.037	0.041*	0.035*	0.027	0.031	0.046**
	(0.587)	(0.402)	(0.661)	(0.026)	(0.026)	(0.003)	(0.003)	(0.003)	(0.002)	(0.026)	(0.024)	(0.027)	(0.023)	(0.023)	(0.020)	(0.021)	(0.020)	(0.019)
Observations	412	412	310	512	512	402	504	504	374	412	412	310	512	512	402	504	504	374
R-squared	0.008	0.009	0.014	0.012	0.022	0.053	0.000	0.002	0.062	0.029	0.061	0.068	0.010	0.020	0.017	0.007	0.012	0.020
Covariates	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
PS	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mean control t0	0.218	0.246	0.216	0.0168	0.0139	0.00819	0.0156	0.0128	0.00596	0.290	0.270	0.261	0.288	0.275	0.249	0.288	0.275	0.244
Mean treated t0	0.199	0.199	0.185	0.0616	0.0616	0.0263	0.0218	0.0218	0.0238	0.436	0.436	0.442	0.362	0.362	0.295	0.303	0.303	0.294
Diff t0	-0.0189	-0.0471	-0.0320	0.0449	0.0478	0.0181	0.00622	0.00904	0.0178	0.146	0.165	0.181	0.0740	0.0872	0.0458	0.0155	0.0285	0.0507
Mean control t1	0.922	0.667	0.980	0.0222	0.0183	0.0106	0.0208	0.0170	0.00826	0.358	0.338	0.323	0.354	0.336	0.302	0.354	0.337	0.295
Mean treated t1	0	0	0	0.0899	0.0899	0.0289	0.0220	0.0220	0.0240	0.546	0.546	0.559	0.465	0.465	0.383	0.397	0.397	0.391
Diff t1	-0.922	-0.667	-0.980	0.0677	0.0716	0.0182	0.00123	0.00504	0.0158	0.188	0.208	0.236	0.111	0.128	0.0809	0.0428	0.0593	0.0963

*** p<0.01, ** p<0.05, * p<0.1. Cluster-robust standard errors in parentheses. Covariate is *elevation*. PS is Kernel-based propensity score matching differences-in-differences and the PS is regressed on *elev*. The balancing property is always satisfied. Column *C.Supp.* satisfies the common support condition required for matching. The settler population in the restricted sample is per thousand. *Sources*: TGdC (1884, 1892, and 1897); see Appendix D for more detail on sources. The instrument is a dummy variable equal to 1 if the region touches the straight lines as shown in Figure C.5 and explained in the empirical section in Chapter 4 .

Table C.13: Diff-in-diff (IV) regressions: effects of railway access on **settler** and **indigenous** population density, Constantine 1884-1897

	Dependent: settler population density									Dependent: indigenous population density								
	Restricted			Full						Restricted			Full					
	No Termini			Termini			No Termini			No Termini			Termini			No Termini		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
VARIABLES	No Cov.	Matched	C.Supp.	No Cov.	Matched	C.Supp.	No Cov.	Matched	C.Supp.	No Cov.	Matched	C.Supp.	No Cov.	Matched	C.Supp.	No Cov.	Matched	C.Supp.
β_3 (diff-in-diff)	-0.492	-0.159	-0.314	0.047	0.048	0.020	0.011	0.012	0.016	0.063	0.058	0.072	0.071*	0.074**	0.057**	0.033	0.036	0.047*
	(0.675)	(0.575)	(0.755)	(0.035)	(0.034)	(0.013)	(0.014)	(0.013)	(0.014)	(0.050)	(0.049)	(0.055)	(0.037)	(0.036)	(0.027)	(0.027)	(0.026)	(0.026)
Observations	412	412	310	512	512	402	504	504	374	412	412	310	512	512	402	504	504	374
R-squared	0.018	0.014	0.018	0.017	0.031	0.061	0.001	0.008	0.057	0.039	0.066	0.072	0.017	0.030	0.028	0.011	0.017	0.024
Covariates	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
PS	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mean control t0	0.218	0.246	0.216	0.0168	0.0139	0.00819	0.0156	0.0128	0.00596	0.290	0.270	0.261	0.288	0.275	0.249	0.288	0.275	0.244
Mean treated t0	0.199	0.199	0.185	0.0616	0.0616	0.0263	0.0218	0.0218	0.0238	0.436	0.436	0.442	0.362	0.362	0.295	0.303	0.303	0.294
Diff t0	-0.0189	-0.0471	-0.0320	0.0449	0.0478	0.0181	0.00622	0.00904	0.0178	0.146	0.165	0.181	0.0740	0.0872	0.0458	0.0155	0.0285	0.0507
Mean control t1	1.181	0.876	1.119	0.0241	0.0199	0.0117	0.0222	0.0182	0.00871	0.382	0.367	0.350	0.376	0.360	0.327	0.376	0.360	0.318
Mean treated t1	0.671	0.671	0.774	0.116	0.116	0.0494	0.0394	0.0394	0.0430	0.590	0.590	0.602	0.521	0.521	0.429	0.424	0.424	0.416
Diff t1	-0.511	-0.206	-0.346	0.0920	0.0961	0.0376	0.0172	0.0212	0.0343	0.208	0.223	0.252	0.145	0.162	0.103	0.0483	0.0642	0.0978

*** p<0.01, ** p<0.05, * p<0.1. Cluster-robust standard errors in parentheses. Covariate is *elevation*. PS is Kernel-based propensity score matching differences-in-differences and the PS is regressed on *elev*. The balancing property is always satisfied. Column *C.Supp.* satisfies the common support condition required for matching. The settler population in the restricted sample is per thousand. *Sources*: TGdC (1884, 1892, and 1897); see Appendix D for detail on sources. The instrument is a dummy variable equal to 1 if the region touches the straight lines as shown in Figure C.5 and explained in the empirical section in Chapter 4 .

Table C.14: Diff-in-diff: effect of railway access on **settler** and **indigenous** population density, economic activity redistribution, Constantine 1884-1892

	Dependent variable: settler population density									Dependent variable: indigenous population density								
	Restricted			Full						Restricted			Full					
Drop variable:	Baseline	10 to 20 km	20 to 30 km	Baseline		10 to 20 km		20 to 30 km		Baseline	10 to 20 km	20 to 30 km	Baseline		10 to 20 km		20 to 30 km	
	No Termini			Term.	No Term.	Term	No Term.	Term.	No Term.	No Termini			Term.	No Term.	Term.	No Term.	Term.	No Term.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
β_3 (diff-in-diff)	-0.721	-1.015	-0.528	-0.004	-0.004	-0.007	-0.006*	-0.005	-0.005	0.054	0.050	0.054	0.030	0.041	0.024	0.035	0.028	0.034
	(0.480)	(0.712)	(0.318)	(0.004)	(0.003)	(0.006)	(0.004)	(0.005)	(0.003)	(0.038)	(0.039)	(0.039)	(0.025)	(0.025)	(0.027)	(0.026)	(0.026)	(0.026)
Observations	406	296	352	504	496	384	376	440	434	406	296	352	504	496	384	376	440	434
R-squared	0.012	0.016	0.013	0.003	0.001	0.001	0.001	0.002	0.000	0.061	0.060	0.078	0.011	0.013	0.010	0.012	0.010	0.013
Covariates	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
PS	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mean control t0	0.250	0.254	0.241	0.0163	0.0127	0.0233	0.0179	0.0186	0.0154	0.259	0.254	0.271	0.275	0.268	0.289	0.281	0.290	0.289
Mean treated t0	0.182	0.182	0.154	0.0284	0.0187	0.0276	0.0181	0.0292	0.0187	0.401	0.401	0.463	0.295	0.291	0.326	0.325	0.301	0.332
Diff t0	-0.0684	-0.0722	-0.0871	0.0120	0.00602	0.00427	0.000268	0.0106	0.00330	0.141	0.146	0.191	0.0205	0.0225	0.0374	0.0434	0.0110	0.0425
Mean control t1	0.836	1.134	0.661	0.0231	0.0170	0.0336	0.0243	0.0268	0.0208	0.325	0.325	0.335	0.336	0.328	0.354	0.344	0.356	0.354
Mean treated t1	0.0463	0.0463	0.0463	0.0317	0.0188	0.0308	0.0182	0.0326	0.0188	0.520	0.520	0.580	0.387	0.392	0.415	0.422	0.394	0.431
Diff t1	-0.790	-1.087	-0.615	0.00854	0.00185	-0.00279	-0.00607	0.00585	-0.00204	0.195	0.196	0.245	0.0509	0.0634	0.0610	0.0780	0.0387	0.0767

Table C.15: Diff-in-diff: effect of railway access on **settler** and **indigenous** population density, economic activity redistribution, Constantine 1884-1897

	Dependent variable: settler population density									Dependent variable: indigenous population density								
	Restricted			Full						Restricted			Full					
Drop variable:	Baseline	10 to 20 km	20 to 30 km	Baseline		10 to 20 km		20 to 30 km		Baseline	10 to 20 km	20 to 30 km	Baseline		10 to 20 km		20 to 30 km	
	No Termini			Term.	No Term.	Term.	No Term.	Term.	No Term.	Termini=No Termini			Term.	No Term.	Term.	No Term.	Term.	No Term.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
β_3 (diff-in-diff)	-0.314	-0.727	0.064	0.020	0.016	0.054	0.015	0.055	0.016	0.077	0.066	0.077	0.054*	0.048	0.039	0.035	0.052*	0.041
	(0.755)	(0.973)	(0.612)	(0.013)	(0.014)	(0.037)	(0.014)	(0.037)	(0.014)	(0.048)	(0.048)	(0.048)	(0.028)	(0.030)	(0.030)	(0.030)	(0.029)	(0.030)
Observations	310	228	274	402	374	308	282	356	334	406	296	352	504	496	384	376	440	434
R-squared	0.018	0.022	0.018	0.061	0.057	0.042	0.046	0.045	0.059	0.071	0.069	0.087	0.021	0.019	0.018	0.017	0.019	0.018
Covariates	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
PS	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mean control t0	0.216	0.237	0.225	0.00819	0.00596	0.0108	0.00743	0.00823	0.00531	0.259	0.254	0.271	0.275	0.268	0.289	0.281	0.290	0.289
Mean treated t0	0.185	0.213	0.200	0.0263	0.0238	0.0665	0.0227	0.0665	0.0238	0.401	0.401	0.463	0.295	0.291	0.326	0.325	0.301	0.332
Diff t0	-0.0320	-0.0240	-0.0249	0.0181	0.0178	0.0558	0.0153	0.0583	0.0184	0.141	0.146	0.191	0.0205	0.0225	0.0374	0.0434	0.0110	0.0425
Mean control t1	1.119	1.470	0.800	0.0117	0.00871	0.0157	0.0112	0.0124	0.00837	0.348	0.354	0.357	0.358	0.350	0.383	0.372	0.379	0.376
Mean treated t1	0.774	0.718	0.838	0.0494	0.0430	0.125	0.0411	0.125	0.0430	0.566	0.566	0.626	0.433	0.420	0.460	0.451	0.441	0.460
Diff t1	-0.346	-0.751	0.0386	0.0376	0.0343	0.110	0.0299	0.113	0.0346	0.218	0.212	0.269	0.0746	0.0707	0.0769	0.0784	0.0626	0.0835

Table C.14 and C.15: *** p<0.01, ** p<0.05, * p<0.1. Cluster-robust standard errors in parentheses. Covariate is *elevation*. The treated variable are the regions below 10 km from nearest railway station. With fixed effects the coefficients and standard errors are almost identical. All regressions are PS Kernel-based propensity score matching differences-in-differences and the PS is regressed on *elev*. The balancing property is always satisfied. Column *C.Supp.* satisfies the common support condition required for matching. The settler population in the restricted sample is per thousand. *Sources*: TGdC (1884, 1892, and 1897); see Appendix D for more detail on sources.

Appendix D

Appendix: General

D.1 Main Sources

- The sources for the historic maps mostly cited in the text are:
  - CEPC (1876): *Carte des Étapes de la province de Constantine* (1876), scale 1/400,000. It is available online in the digital library Gallica from the *Bibliothèque nationale de France*, retrieved from `http://catalogue.bnf.fr/ark:/12148/cb40683086f`.
  - CEPC (1883): *Carte des Étapes de la province de Constantine* (1883), scale 1/1,000,000. It is available online in the digital library Gallica from the *Bibliothèque nationale de France*, retrieved from `http://catalogue.bnf.fr/ark:/12148/cb40727576d`.
  - CCO (1902): *Carte de la colonisation officielle, Algérie* (1902), scale 1:800 000. It is available online in the digital library Gallica from the *Bibliothèque nationale de France*, retrieved from `http://catalogue.bnf.fr/ark:/12148/cb40710721s`.
  - CVC (1902): *Carte des voies de communication. Département de Constantine* (1902), scale 1/400.000. It is not available for download online; thus, I purchased it through the website `https://www.delcampe.net`.
  - CCOA (1919): *Carte la colonisation officielle en Algérie* (1919), scale 1/1.500.000. It is available online in the digital library Gallica from the *Bibliothèque nationale de France*, retrieved from `http://catalogue.bnf.fr/ark:/12148/cb40719148b`.
  - CLA (1939, 1949): *Carte des Limites Administratives, Departement de Constantine* (1939, 1949). They are not available for download online; thus, I purchased them through the website `https://www.delcampe.net`.
  - CVC (1955): *Voies de Communication. Departement de Constantine* (1955). It is not available for download online; thus, I purchased it through the website `https://www.delcampe.net`.

- Other sources frequently cited in the text are:

  - SA (1904/05, 1913/14): *Statistique Agricole: État Recapitulatif* collected by the *Gouvernement Général de l'Algérie, Direction de l'Agriculture, de la Colonisation, du Commerce et de l'Industrie, Service de la Statistique Générale*. These statistics are located in ANOM and provide agricultural information for Constantine mainly for the years 1904/05 and 1913/14. The location in the archives are: *Campagne annuelles* 93/1H/59/1,2,3, *Campagne annuelles* 93/1H/60, *Campagne annuelles* 93/1H/61/1-9, and *Campagne annuelles* 93/1H/62.

  - TGdC (1884, 1892, 1897, 1902): *Tableau Général ... des communes de plein exercice, mixtes et indigènes des trois provinces (territoire civil et territoire militaire): avec indication du chiffre de la population et de la superficie. Gouvernement Général de l'Algérie, Direction Générale des affaires civiles et financières*. This source is available online in the Gallica digital library from the *Bibliothèque nationale de France*, retrieved from `http://gallica.bnf.fr/ark:/12148/cb39214483r/date&rk=42918;4`. There are four years available : 1884, 1892, 1897, and 1902. It provides information on the municipal population density and area covered based on the nationality and type of settlement (i.e., settlement centers, portions of land, *douars*, and tribal areas).

  - DdC (1878): The *Dictionnaire des communes, villes et villages de l'Algérie... : précédé d'une introduction sur l'Algérie/ par Achille Fillias* . This source is available online in the Gallica digital library from the *Bibliothèque nationale de France*, retrieved from `http://gallica.bnf.fr/ark:/12148/bpt6k104479b/f2.image`. There in only one volume available for 1878. It reports general information such as the type of settlement, the administrative circumscription, the presence of markets, *justice de paix*, banks, schools, postal services, churches, natural resources, train stations, etc.

  - ASF (several years): The *Annuaire Statistique de la France* from the *Ministère de l'agriculture et du commerce, Service de la statistique générale de France, Direction de la statistique générale*. This source is available online in the Gallica digital library from the *Bibliothèque nationale de France*, retrieved from `http://catalogue.bnf.fr/ark:/12148/cb343503965`. After the 1900s the volume is called *Annuaire Statistique* from the *Ministère du commerce, de l'industrie, des postes et télégraphes, Office du travail, Statistique générale de la France* and it is also available online in Gallica digital library from the *Bibliothèque nationale de France*, retrieved from `http://catalogue.bnf.fr/ark:/12148/cb34350395t`.

  - ANOM and ANOM-iREL: ANOM are the *Archives Nationales d'Outre-Mer* and ANOM-iREL are the *Archives Nationales d'Outre-Mer-Instruments de Recherche en Ligne*. The colonial archives are located in Aix-en-Provence and the online information is retrieved from `http://anom.archivesnationales.culture.gouv.fr/geo.php?ir=`.

D.2 Variable Description

- *EurAgricPop/ha* is the rural settler population per hectare; more specifically, it is the total number of European laborers, sharecroppers, tenants, and owners divided by the total number of cultivated and non-cultivated European-owned hectares. The population data was obtained from FR CAOM 93/1H60 (for the year 1904/05) and FR CAOM 93/1H61 (for the year 1913-1914) in the folder on *La population agricole par catégories et par nationalités résidant dans la commune* in the *Archives Nationales d'Outre Mer* in Aix-en-Provence.

- *Creation* (or *average year of settlement*) is the average year of creation of the settlement centers in a municipality. The information was collected from different sources. The webpage ANOM-iREL allows to search for historic settlements based on their colonial administrative name. The ANOM-iREL search engine shows the current geographic location of settlement points and, occasionally, it also provides information on administrative changes regarding names, territorial boundaries, year of establishment, type of municipality (CPE, CM, and CI), etc. In addition, this information has been complemented with Busson (1898), the available TGdC (for instance, the latter provides the *ordennance* dates of territorial enlargementes), and the *Atlas Administratif de l'Algérie 1830-1960*. I have also obtained information from. Sometimes, it has been necessary to make a judgment call; for instance, the settlement center Randon was created/established in 1868 but populated in 1874, thus I kept the latter as it reflects more accurately the moment of settlement and land concessions. I have not included in the sample the settlement year of military posts (as they did not imply land distribution) and, when available, I have included what was classified as the "projected" year of settlement.

- *IndexLC_E* is the European land concentration index. It is a weighted index ranging from 1 (if there are only properties below 10 hectares) up to 6 (if there are only properties above 100 hectares) for each municipality. To construct it, I first assigned values to each property size category: the value of 1 to properties below 10 hectares, 2 for properties between 11 and 20 hectares, 3 for properties between 21 and 30, 4 to 31-40, 5 to 41-100 and 6 to properties above 100 hectares. To obtain an index that ranges from 1 to 6, I then multiplied each value by its corresponding share over the total number of properties. The sources are FR CAOM 93/1H60 (for the year 1904/05) and FR CAOM 93/1H61 (for the year 1913/14) in the folder *Le nombre des propriétés agricoles particuliéres; Leur repartition d'aprés leur étendue et la nationalité des propriétaires* in the *Archives Nationales d'Outre Mer* in Aix-en-Provence.

- The variable *ShareProp>41ha* (or *average size of large properties*) is the share of European properties above 41 hectares over the total number of properties per municipality. The data was obtained from FR CAOM 93/1H60 (for the year 1903/04) and FR CAOM 93/1H61 (for the year 1913/14) in the folder *Nombre des propriétés agricoles particuliéres. Répartition d'après leur étendue et la nationalité des propriétaires* in ANOM in Aix-en-Provence.

- *AverPropSize(I)* (also called *Average size per property*) is the European average property size in hectares per municipality. The mean value for each group category was assigned: 5 to properties below 10 hectares, 15 for the properties between 11 and 20 hectares, 25 to the ones between 21 and 30, 35 to 31-40, to 41-100 and 100 to the number of properties above 100 hectares. It was obtained from FR CAOM 93/1H60 (for the year 1903/04) and FR CAOM 93/1H61 (for the year 1913/14) in the folder *Le nombre des propriétés agricoles particuliéres; Leur repartition d'aprés leur étendue et la nationalité des propriétaires* in ANOM in Aix-en-Provence. Given that this variable requires establishing an upper size limit to the properties above 100 hectares, I created dummy variables (*D_Aver>100ha* and *D_Aver>500ha*) for the municipalities which, according to a different source, were clearly endowed with very large properties (see Figure A.1). The data for the latter was obtained from the area data in FR CAOM 93/1H60 (for the year 1903/04) and FR CAOM

93/1H61 (for the year 1913/14) in the folder *Superficie du territoire -Répartition des parties cultivées et non cultivées entre les differentes catégories des propriétaires*.

- *AverPropSize(II)* is the European average property size in hectares calculated from a different source of *AverPropSize(I)*. I directly divide the number of all European-owned rural properties by the number of properties. However, the numerator and denominator come from different sources and thus it is questionable whether this variable is accurate. The source for the number of all European-owned rural properties comes from FR CAOM 93/1H60 (for the year 1903/04) and FR CAOM 93/1H61 (for the year 1913/14) in the folder *Superficie du territoire -Répartition des parties cultivées et non cultivées entre les differentes catégories des propriétaires* and the source for the number of properties was obtained from FR CAOM 93/1H60 (for the year 1903/04) and FR CAOM 93/1H61 (for the year 1913/14) in the folder *Le nombre des propriétés agricoles particuliéres; Leur repartition d'aprés leur étendue et la nationalité des propriétaires* in ANOM in Aix-en-Provence.

- *GINI* index is a variable measuring the property size distribution per municipality. To construct it, I assigned the average size for each property size category: for properties below 10 hectares the average size is 5, for the category 11-20 it is 15, for 21-30 it is 25, for 31-40 it is 35, for 41-100 is 70.5, and for the category above 100 I assumed 100 hectares. However, as explained in Chapter 2, this variable is not appropriate to measure land concentration given that, if all properties are bigger than 100 hectares ina given municipality, then it would reflect perfect equality and neglect the relevance of large size ownership. The source is FR CAOM 93/1H60 (for the year 1903/04) and FR CAOM 93/1H61 (for the year 1913/14) in the folder *Le nombre des propriétés agricoles particuliéres; Leur repartition d'aprés leur étendue et la nationalité des propriétaires* in ANOM in Aix-en-Provence.

- The variable *ShareProp<10ha_E* is the share of European properties below 10 hectares for the years 1904/05 and 1913/14 per municipality. It is the number of European properties below 10 hectares over the total number of European-owned properties. The data was obtained from FR CAOM 93/1H60 (for the year 1903/04) and FR CAOM 93/1H61 (for the year 1913/14) in the folder on *Nombre des propriétés agricoles particuliéres. Répartition d'après leur étendue et la nationalité des propriétaires* in ANOM in Aix-en-Provence.

- The variable *ShareProp>100ha_E* is the share of European properties greater than 100 hectares for the years 1904/05 and 1913/14 per municipality. It is the number of European properties above 100 hectares over the total number of European-owned properties. The data was obtained from FR CAOM 93/1H60 (for the year 1903/04) and FR CAOM 93/1H61 (for the year 1913/14) in the folder *Nombre des propriétés agricoles particuliéres. Répartition d'après leur étendue et la nationalité des propriétaires* in ANOM in Aix-en-Provence. From the same folders I also calculated the *average size of large properties* dividing the number of European properties above 100 hectares divided by the total number of European-owned properties.

- *RoadNetwork* is the road infrastructure density; that is, the ratio between the length of roads (in meters) and the municipality area (in hectares). The roads included are *Routes Nationales*, *Chemins de Grande Communication*, and *Chemins d'Intérêt Commun*. The length of the road network for each municipality was calculated using the Africa Albers Equal Area Conic projection (ESRI: 102022). In order to digitize the old roads, I georeferenced the historic 1902 *Carte de Voies de Communication* transports map to the current road infrastructure (available at the Digital Chart of the World GIS dataset. The roads classified as *en lacune* in the 1902 map are not included.

- *Railway network* (*ShortPthRW*) is the total distance in hours adding: i. the average distance between the municipality's settlement points and the nearest station (assuming a walking speed of 5 km per hour)) and, ii.

the distance between the station and the nearest port following the shortest railway line route (assuming a railway speed of 24 km per hour). The data was obtained from webpage DIVA-GIS or geo-community, for which the original source is the Digital Chart of the World. To adapt the current railway lines to the historic ones, I overlaid the 1902 map *Voies de Communication* to the current railway lines. I created three different variables per municipality: railway station density (number of stations over municipality area), railway line density (length of railway lines over municipality area), and average distance to nearest port. To calculate the latter, I first averaged the distance in kilometers between each *centres* or *fermes de colonisation* and its respective nearest station. Then I added to the latter the distance in kilometers from the railway station to the nearest port. A judgment call was needed to select which was the nearest port; for instance, when the distance from two different ports to the same station was not significantly different, I selected the route that went to the most important port. When no railway was needed to arrive to the port, then I only include the traveling time between the settler town and the port. I used GIS software and the Africa Albers Equal Area Conic projection (ESRI: 102022).

- *Sett/Ind_84* is the ratio settler to indigenous population in 1884 aggregated at a municipality level. The data was obtained from the TGdC for the year 1884.[1]The settlers are proxied by the French population and the indigenous are proxied by *Indigènes musulmans*. The source provides the information disaggregated at a sub-municipal level (such as villages or tribal areas). Spatial grids containing the demographical information on the covered regions were spatially joined into the *communes*, calculating the weighted averages according to the area. The neglected sub-municipalities in the calculation are relatively remote tribal areas that experienced too many territorial changes prohibiting the aggregation into *communes*.

- The *Owners/ha_*I (or *IndigOwnersDens*) is the number of indigenous owners divided by the area of all cultivated and non-cultivated properties.[2] It was obtained from FR CAOM 93/1H60 (for the year 1903-1904)and FR CAOM 93/1H61 (for the year 1913-1914) in the folder *La population agricole par catégories et par nationalités résidant dans la commune*.

- The *ShareOwners_I* (or *IndigOwnersShare*) is the number of indigenous owners divided by the total indigenous rural population. It was obtained from FR CAOM 93/1H60 (for the year 1903-1904) and FR CAOM 93/1H61 (for the year 1913-1914) in the folder *La population agricole par catégories et par nationalités résidant dans la commune*.

- *Light density at night* was obtained from NOAA's National Geophysical Data Center in the Global DMSP-OLS Nighttime Lights Time Series 1992-2013 (Version 4) (https://ngdc.noaa.gov/eog/download.html). As described in the webpage, it contains "the lights from cities, towns, and other sites with persistent lighting, including gas flares. Ephemeral events, such as fires have been discarded. Then the background noise was identified and replaced with values of zero. Data values range from 1-63. Areas with zero cloud-free observations are represented by the value 255." I averaged the light density values corresponding to 30 arc second grids for each municipality obtained.

- *CropSuit* (or *Crop Suitability*) is the crop suitability index (class) for low input level rain-fed wheat from IIASA/FAO Global Agro-Ecological Zones. The highest value is 9 while the lowest suitability value is 1.[3] The model used to build this index considers the average climate for the period 1961 and 1990 and, as IIASA/FAO explain, it accounts for wheat cultivation under subsistence production without necessarily being oriented towards markets, labor intensive techniques, and no nutrients, chemicals or disease control,

[1].

[2]I also calculated the number of owners per cultivated area and results are almost identical.

[3]For convenience, the order has been modified so that 1 stands for lowest suitability and 9 for highest (1 is 8, 2 is 7, 3 is 6, 4 is 5, 5 is 4, 6 is 3, 7 is 2 and 8 is 1).

and minimum conservation measures. I used GIS software to measure this suitability within the colonization areas drawn in the historic maps. Thus, I first calculated the area (in hectares) for the settlement centers (using Albers equal-area conic projection) and then calculated the weighted average suitability within the area of each colonization center. The source is IIASA/FAO, 2010. Global Agro-Ecological Zones (GAEZ v3.0). IIASA, Laxenburg, Austria and FAO, Rome, Italy.

- *DWine* is a dummy measuring whether there are suitable hectares for wine cultivation in a colonization center. This variable was built following wine suitability criteria considering pH, rainfall, frost free period, and slope.[4] Given its high correlation with wheat suitability (*CropSuit* variable) and non-exclusion (i.e., the land suitable for wine was also appropriate for wheat), I only include the dummy variable in the model. The value is 1 when more than 20 percent of the total colonization area is suitable and zero if less. Several variables must be taken into consideration to measure land suitability to viticulture such as the length of the frost free period, extreme minimum winter temperatures, and growing degree days (Chen, 2011). The criteria used for suitability are the following: i. the areas must comply with more than 500 mm of average annual rainfall within a year;[5] ii, the frost free period (baseline period 1961-1990) – i.e., the number of days throughout the year with low risk of early and late frosts (days with average temperature of 10°C)[6] – is above 200 days allowing grapes to ripe; iii. the pH must be below 8 given that suitability in water for vine growing ranges between 5.5 and 7 or 8 (above 8 usually creates nutritional problems);[7] iv. the steepness, which affects internal soil drainage, must be lower than 45 (although it is not recommended above 15.[8]; finally, drainage is not included due to lack of variation across the regions under study.[9]

- The variable *ShareWine_E* (or *share of wine*) is the number of European cultivated hectares devoted to viticulture over the total European cultivated area for the years 1904/05 and 1913/14 per municipality. The data was obtained from FR CAOM 93/1H60 (for the year 1903/04) and FR CAOM 93/1H61 (for the year 1913/14) in the folder *Superficie du territoire-Répartition des parties cultivées et non cultivées entre les differentes catégories des proprietáires* in ANOM in Aix-en-Provence.

- The variable *ShareCereal_E* (or *share of cereal*) is the number of the cereal-cultivated hectares by Europeans over the total area cultivated by Europeans for the years 1904/05 and 1913/14 per municipality. The data was obtained from FR CAOM 93/1H60 (for the year 1903/04) and FR CAOM 93/1H61 (for the year 1913/14) in the folder *Superficie du territoire-Répartition des parties cultivées et non cultivées entre les differentes catégories des proprietéires* in ANOM in Aix-en-Provence.

- The variable *AreaCereal_E* is the total cereal-cultivated area by Europeans in hectares for the years 1904/05 and 1913/14 per municipality. The data was obtained from FR CAOM 93/1H60 (for the year 1903/04) and FR CAOM 93/1H61 (for the year 1913/14) in the folder *Superficie du territoire-Répartition des parties cultivées et non cultivées entre les differentes catégories des proprietáires* in ANOM in Aix-en-Provence.

[4]Mainly based on research by White (2010) and Chen (2011).

[5]Most literature argues that at least 690 millimeters (27 in) of rainfall are necessary to produce grapes for wine, yet the boundary set in this paper is lower to avoid being too strict.

[6]It is the same as the length of the "temperature growing period" (number of days in year when average daily temperature is above 10°C)

[7]The data for pH was the mean estimator obtained from ISRIC for 80 cm depth.

[8]GIS provided the data in square meters and it was divided by 10 thousand. The projection is AEAA. The data was obtained from Fischer et al. (2008) found in the databases provided by FAO with IIASA, ISRIC-World Soil Information, Institute of Soil Science, Chinese Academy of Sciences (ISSCAS), and the Joint Research Centre of the European Commission (JRC).

[9]They all appear under no drainage constraints with the exception of a small region in the north east with moderate constraints.

- The variable *AreaWine_E* is the total viticulture-cultivated area by Europeans per municipality in hectares for the years 1904/05 and 1913/14. The data was obtained from FR CAOM 93/1H60 (for the year 1903/04) and FR CAOM 93/1H61 (for the year 1913/14) in the folder *Superficie du territoire-Répartition des parties cultivées et non cultivées entre les differentes catégories des proprietáires* in ANOM in Aix-en-Provence.

- The variable *LandPrice_E* is the average land value of one hectare of non-cleared land for Europeans per municipality. The data is also available for cleared land and tenancy rates. It was obtained from FR CAOM 93/1H60 (for the year 1903/04) and FR CAOM 93/1H61 (for the year 1913/14) in the folder *Superficie du territoire-Répartition des parties cultivées et non cultivées entre les differentes catégories des proprietáires* in ANOM in Aix-en-Provence.

- The variable *W/day_I* measures the agricultural wages paid to the indigenous population divided by the corresponding total amount of days worked for the years 1904/05 and 1913/14 per municipality. The data was obtained from FR CAOM 93/1H60 (for the year 1903/04) and FR CAOM 93/1H61 (for the year 1913/14) in the folder on *Ouvriers, Journées Agricoles-Salaires* in ANOM in Aix-en-Provence.

- The variable *MachPrice* is the value in francs of a steam tractor per municipality for the years 1904/05 and 1913/14. The data was obtained from FR CAOM 93/1H60 (for the year 1903/04) and FR CAOM 93/1H61 (for the year 1913/14) in the folder *Matériel agricole* in ANOM in Aix-en-Provence.

- The variable *Lab/day_I* is the number of agricultural indigenous laborers employed divided by the total number of days worked per municipality for the years 1904/05 and 1913/14 respectively. The data was obtained from FR CAOM 93/1H60 (for the year 1903/04) and FR CAOM 93/1H61 (for the year 1913/14) in the folder *Ouvriers, Journées Agricoles-Salaires* in ANOM in Aix-en-Provence.

- The variable *Land/Labor* (or also *Land/Labor (I)* is the annual number of European-owned cultivated hectares over the total number of indigenous laborers employed in the agricultural seasons per municipality for the years 1904/05 and 1913/14 respectively. The labor data comes from FR CAOM 93/1H60 (for the year 1903/04) and FR CAOM 93/1H61 (for the year 1913/14) in the folder *Ouvriers, Journées Agricoles-Salaires* and the area data was obtained from FR CAOM 93/1H60 (for the year 1903/04) and FR CAOM 93/1H61 (for the year 1913/14) in the folder *Superficie du territoire-Répartition des parties cultivées et non cultivées entre les differentes catégories des proprietáires* in ANOM in Aix-en-Provence. The variable *Land/Labor (II)* is the number of European-owned cultivated hectares in large landholdings (above 40 hectares) over the total number of indigenous laborers employed in the agricultural seasons per municipality for the years 1904/05 and 1913/14. To calculate the large landholding area, I subtracted to the total European cultivated area the product between the mean value for each group category below 40 hectares (that is, 5 to properties below 10 hectares, 15 for the properties between 11 and 20 hectares, 25 to the ones between 21 and 30, and 35 to 31-40) and the number of hectares corresponding to each category. The data for the number of properties per size category was obtained from FR CAOM 93/1H60 (for the year 1903/04) and FR CAOM 93/1H61 (for the year 1913/14) in the folder *Le nombre des propriétés agricoles particuliéres; Leur repartition d'aprés leur étendue et la nationalité des propriétaires* in ANOM in Aix-en-Provence. The total cultivated data comes from the folder *Superficie du territoire-Répartition des parties cultivées et non cultivées entre les differentes catégories des proprietáires* and the labor data comes from FR CAOM 93/1H60 (for the year 1903/04) and FR CAOM 93/1H61 (for the year 1913/14) in the folder *Ouvriers, Journées Agricoles-Salaires*.

- Several variables are used to measure mechanization density per European-owned cultivated hectares per municipality for the years 1904/05 and 1913/14 respectively: (i) number of tractors (*Mach/ha_E*), (ii) number of threshers (*Tresh/ha_E*), number of mechanical reaper or harvester (*Harv/ha_E*), (iv) number of French plows (*FrPlow/ha_E*), v. other tools that include (i),(ii), (iii), and (iv) plus viticulture-specific instruments.

In addition I include a *modernization* indicator that is the ratio between French plows used by Europeans and indigenous plows used by Europeans. All variables with the exception of *modernization* (vi) are per thousand. The data was obtained from FR CAOM 93/1H60 (for the year 1903/04) and FR CAOM 93/1H61 (for the year 1913/14) in the folder *Matériel agricole* in the *Archives Nationales d'Outre Mer* in Aix-en-Provence.

- The variable *YcerW/ha_E* or *Wheat Production per cultivated hectares* is the winter cereal (grain) quintals per European-owned cultivated hectares. Winter Cereals include soft wheat, hard wheat, rye, barley, oats. The data was obtained from FR CAOM 93/1H60 (for the year 1903/04) and 93/1H/61/1-9 (for the year 1913/14) in the folder *Céréales et les produits alimentaires autres que les céréales. Blé tendre, blé dur, seigle, orge, avoine, mais, bechna (sorgho), millet.* in the *Archives Nationales d'Outre Mer* in Aix-en-Provence.

- The variable *ShareModeEurop_E* (or *Share Cultivated Á la Mode Européenne*) are the number of hectares cultivated *á la mode européenne* by both indigenous and Europeans (including Israelites) over the total number hectares cultivated (by Europeans and indigenous) per municipality for the years 1904/05 and 1913/14 respectively. The data was obtained from FR CAOM 93/1H60 (for the year 1903/04) and FR CAOM 93/1H61 (for the year 1913/14) in the folder *Superficie du territoire - Répartition des parties cultivées et non cultivées entre les differentes catégories des proprietáires* in the *Archives Nationales d'Outre Mer* in Aix-en-Provence.

- The variable *Wheat cultivated area per settler* is the total cereal-cultivated Europeans-owned hectares divided by the total rural settler population per municipality for the years 1904/05 and 1913/14 respectively. The data was obtained from FR CAOM 93/1H60 (for the year 1903/04) and FR CAOM 93/1H61 (for the year 1913/14) in the folder *Superficie du territoire - Répartition des parties cultivées et non cultivées entre les differentes catégories des proprietáires* in ANOM in Aix-en-Provence.

- The variable *Wheat cultivated area per property* is the total European-owned, cereal-cultivated hectares divided by the total rural settler population per municipality for the years 1904/05 and 1913/14 respectively. The data was obtained from FR CAOM 93/1H60 (for the year 1903/04) and FR CAOM 93/1H61 (for the year 1913/14) in the folder *Superficie du territoire-Répartition des parties cultivées et non cultivées entre les differentes catégories des proprietáires*. I also calculated the *Wheat cultivated area per property* that is the total European-owned, cereal-cultivated hectares divided by the total number of properties per municipality for the years 1904/05 and 1913/14 respectively.

- The variable *Oxen per hectare* is the total number of oxen divided by the owned hectares for the years 1904/05 and 1913/14 respectively. The data was obtained from FR CAOM 93/1H60 (for the year 1903/04) and FR CAOM 93/1H61 (for the year 1913/14) in the folder *Animaux de ferme* in the *Archives Nationales d'Outre Mer* in Aix-en-Provence. I have calculated it for both the settler and the indigenous population.

- The variable *Laborers/ha_I* or *Indigenous Laborer per Hectare* is the number of agricultural indigenous laborers employed divided by the total European-owned number of hectares cultivated in a municipality for the years 1904/05 and 1913/14. The data was obtained from FR CAOM 93/1H60 (for the year 1903/04) and 93/1H/61/1-9 (for the year 1913/14) in the folder *Population agricole par categories et par nationalités résidant dans la commune* in the *Archives Nationales d'Outre Mer* in Aix-en-Provence.

- The variable *Sharecropper/ha_I* or *Indigenous Sharecropper per hectare* is the number of agricultural indigenous sharecroppers divided by the total European and indigenous-owned number cultivated hectares in a municipality for the years 1904/05 and 1913/14. The data was obtained from FR CAOM 93/1H60 (for the year 1903/04) and 93/1H/61/1-9 (for the year 1913/14) in the folder *Population agricole par categories et par nationalités résidant dans la commune* in the *Archives Nationales d'Outre Mer* in Aix-en-Provence.

- The *IndAgricPop/hasuit* or *indigenous rural population per hectare* is the total number of the rural indigenous population (laborers, sharecroppers, tenants, and owners) divided by the total number of hectares with a crop suitability index above 4 (or medium level) for low input level rain-fed wheat. See the description for the *Crop suitability* variable in this Appendix. The data was obtained from FR CAOM 93/1H60 (for the year 1903/04) and 93/1H/61/1-9 (for the year 1913/14) in the folder *Population agricole par categories et par nationalités résidant dans la commune* in the *Archives Nationales d'Outre Mer* in Aix-en-Provence.

- The variable *Indden* or *indigenous density* is the indigenous municipal population per hectare. In the TGdC it is classified as 'Sujets Français, Arabes, Kabyles, M'zabites et israélites du M'zab' located in the civil territory. I divided the total population per the corresponding area in hectares from the same source. The source is the TGdC for the years 1884, 1892, and 1897.

- The variable *Settden* or *settler density* is the settler municipal population under the category 'Français' in the civil territory.[10] It is divided by the corresponding area in hectares from the same source. It does not include the naturalized Israelites. The source is the TGdC for the years 1884, 1892, and 1897.

- *Dummy< 10km* is a dummy variable equal to one if the centroid within the unit of observation (i.e., mainly settlement centers and *douars*) is located at a distance below 10 km from the nearest train station.

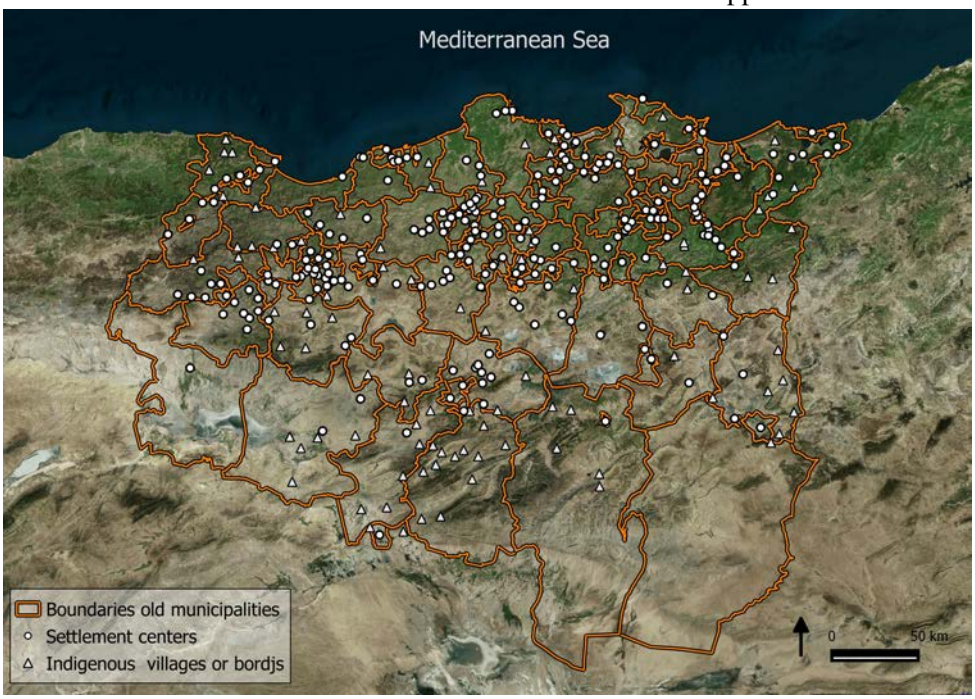
- *Dummy< 20km* is a dummy variable equal to one if the centroid within the unit of observation (i.e., mainly settlement centers and *douars*) is located at a distance below 20 km from the nearest train station.

- *Elevation* (or *Elev*) is the average elevation for each unit of observation (that is, settlement center, *douar*, etc.) and was calculated using GIS software. It is available online at a 3 arc second in http://srtm.csi.cgiar.org. The source is the CGIAR-CSI (2006), NASA Shuttle Radar Topographic Mission (SRTM).

[10]The French population represents always the largest share of the total European population.

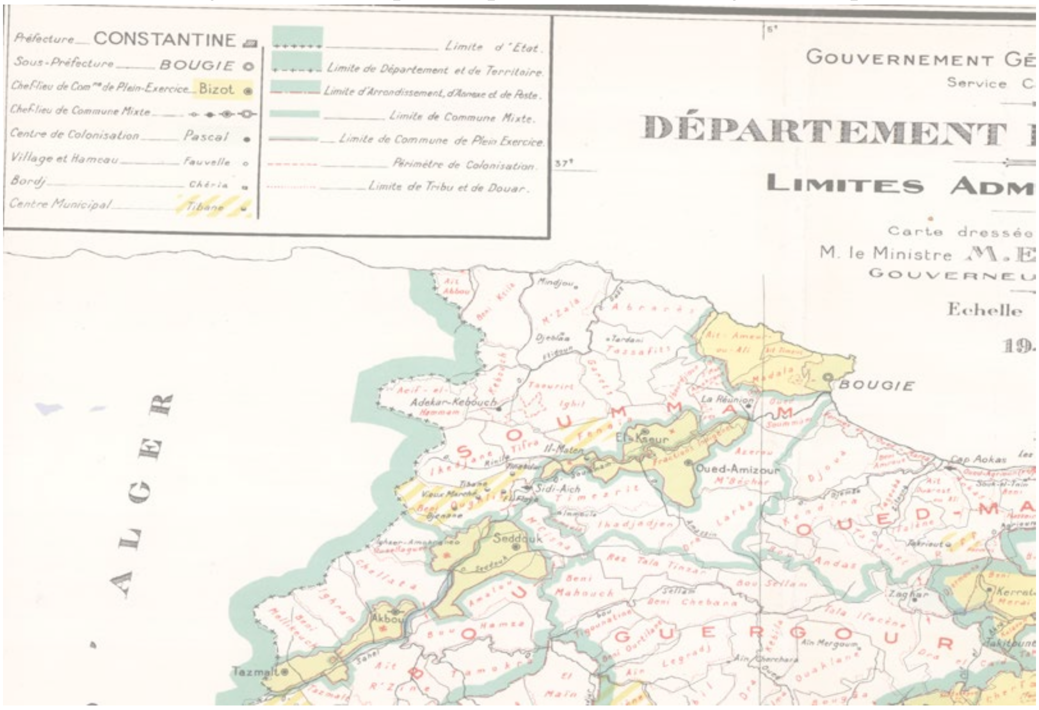
D.3 Maps and Images

Figure D.1: Colonial administrative boundaries in Constantine overlapped to current aerial image



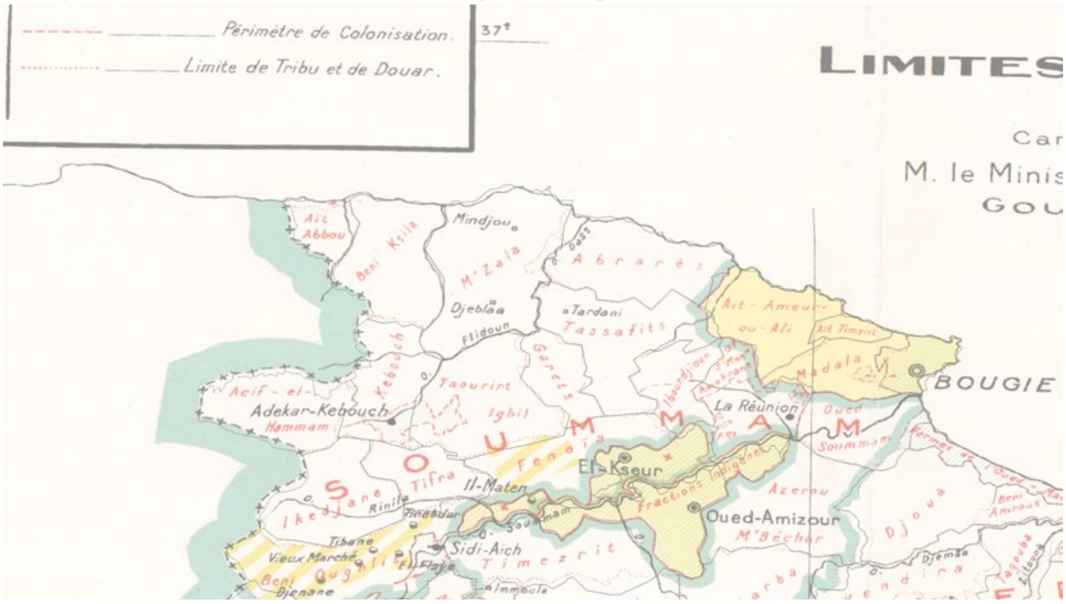
The aerial image has been obtained from GIS software (Bing Aerial). *Source*: CEPC (1883), CVC (1902), Busson (1898), and ANOM-iREL. See Appendix D for more detail on sources and construction of spatial dataset.

Figure D.2: Example of a part Constantine's digitized map



Source: *Statistique Agricole : État Recapitulatif*, by the *Gouvernement Général de l'Algérie*, *Direction de l'Agriculture, de la Colonisation, du Commerce et de l'Industrie, Service de la Statistique Générale*

Figure D.3: Zoom-in Constantine's digitized map: *douars* from 1863 *sénatus-consulte*



Source: *Statistique Agricole : État Recapitulatif*, by the *Gouvernement Général de l'Algérie*, *Direction de l'Agriculture, de la Colonisation, du Commerce et de l'Industrie, Service de la Statistique Générale*

D.4 Trade and Population

This section presents the methodology used to construct the price index and the export basket used in Chapter 1 in Figure 1.3, 1.5, and 1.7. It additionally explains the procedure implemented to estimate the long term series for the settler and indigenous population, allowing to express values in per capita terms (in Figure 1.5).

Price Index and Real Exports

The price index is a weighted index whose components are balanced according to the prices of their outstanding shares within total exports. I multiplied the current annual weight of each selected export (over their total aggregated value) and by its corresponding price (constant prices relative to 1902 (1902=1)). The price data is not directly available from the Algerian statistical sources (or at least not up to my knowledge). For this reason I use the French prices available in the ASF (*Annuaire Statistique de la France*),[11] Clark (2004), Sauerbeck (1886), and Mitchell (1988). Given that commercial trade in Algeria specialized in a limited number of products, the price index includes only the prices for wine, wheat (grain and flour), and livestock (sheep and cattle), which should reflect a representative Algerian export basket. I used the French agricultural wholesale prices (in francs) after 1857.[12] The price for wheat flour (francs per kilogram) is used to proxy for cereals.[13] With regard to wine prices (francs per hectolitre), I used Mitchell's (1992) data.[14] For livestock I selected sheep and cattle prices (in francs per kilogram) reported in ASF (1935).

Cereal and livestock exports (in francs) were obtained from the annual ASF and the wine exports from Mitchell (1994). The data from the ASF required aggregating categories to build a homogeneous time series, in addition to minor corrections and interpolations.[15] However, given that the trade data in this thesis is only used to provide a general and descriptive overview, I am not giving further detail on the categorization and methodology used to build the time series. Still, it is relevant to mention that there are some potential compilation errors; for example, as Girault (1916, p. 255) explains, the recorded statistical mismatching between Algeria and French

[11] Which comes originally from the *Tableau du commerce de la France, Direction Générale des Douanes*. I mostly relied on the 1930, 1935, and 1966 French yearbooks.

[12] The official sources also provide retail prices (consumer) and, occasionally, it is possible to infer prices from the general commerce data using the official exported values in francs and quantities. The figures used are the import values after the evaluation of the Valuation Commission

[13] The wheat flour prices show the highest correlations with all the other types of cereal.

[14] Using Mitchell (1988) as opposed to the data from the ASF does not make a difference since both series hold an above 90 percent correlation between 1865 and 1935.

[15] The export data reported in the ASF has continuous nomenclature changes and sometimes the values refer to special commerce (which is the one that enters in circulation in the country), while others it refers to general trade. In some years, the export values to France are reported separately from the exports to other countries, whereas in other occasions they are aggregated. Additionally, regarding the calculated weights for each product, since part of the data was obtained from Mitchell (1994) (wine and total exports) and the rest from the ASF, the sum of the weights is not perfect (accounting always below or equal to one hundred percent). Thus, the weights have been adjusted to add one.

customs in some years could be of "ten francs per hectoliter in Algeria and fifteen francs per hectoliter in France." These differences often relate to the valuation system in each country (i.e., *official values* and *actual values*) and might be biased depending on fiscal interests instead of statistical ones (due to lobbies or other factors) (Federico and Tena-Junguito, 2013).[16] Thus, it is to keep in mind that the real export series constructed in this section are approximations that are a first step towards the creation of a more detailed and accurate long term series.

Population Series

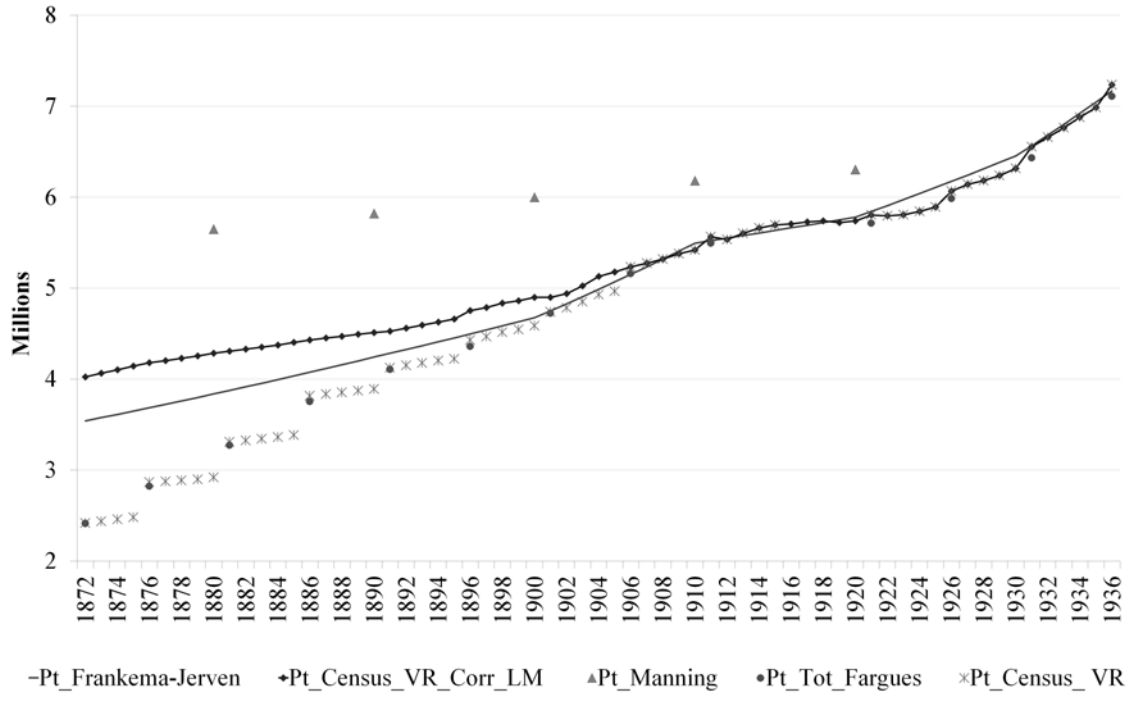
This section estimates an annual population series for Algeria between 1872 and 1936. It primarily focuses on the improvement of the indigenous population estimates given that the European population in colonial Algeria (including information on vital rates and civil status) is found to be sufficiently covered and precise after the 1870s (Kateb, 2001, p. 246). The results show that population was approximately 4 million in 1872 and that the initial growth rates ranged around 0.25 percent, thus standing between Manning's (2010) estimates and the reported census observations. Moreover, results stand against the constant 1 percent growth rate applied by Frankema and Jerven (2014) between the 1850s and 1906, finding that the latter was reached in the 1890s.

Current State of Research

Only few authors have estimated the annual population time series for Algeria (Frankema and Jerven, 2014; Manning, 2010; Fargues, 1986). Improving Algerian estimates ameliorates overall African datasets; for instance, regarding North Africa, the most recent estimates provided by Frankema and Jerven (2014) assume that the population growth rates in Algeria can be equally applied to Tunisia and Morocco. Thus, reconstructing the Algerian series contributes to the general debate on African population trends and long-term economic growth and development. Although there is a general consensus that censuses tend to underestimate population in Algeria, there is disagreement on the corrections to be made. Patrick Manning questions the World Bank's conventional estimates, while Frankema and Jerven find that Manning's results overestimate population and underestimate growth. Graph D.4 provides an idea of the current disagreement on Algerian population figures and displays the results obtained in this section (in graph *Pt_Census_VR_Corrected_LM*). The series *Pt-Frankema-Jerven* presents the estimates from Frankema and Jerven (2014), *Pt_Manning* reflects the ones from Manning (2010), and *Pt_Tot_Fargues* shows the estimates from Fargues (1986). The series reflect significant differences; for instance, Manning's initial values surpass Frankema and Jerven's by almost a 50 percent in 1880n while Frankema and Jerven's are above the census observations (shown in series *Pt_Census_VR*) by almost 50 percent in 1872. Although the estimates built in this section (*Pt_Census_VR_Corrected_LM*) are not far from Frankema and Jerven's, they position between the latter and Manning's values.

[16]The Algerian commerce data reported in the French statistical yearbooks shows that until 1890 the values are official and, afterwards, they are actual (in contrast to the actual values reported in France).

Figure D.4: Total population estimates, French Algeria 1872-1936



Source: Frankema and Jerven (2014), Manning (2010), Fargues (1986), and see text for more detail.

To estimate and infer population backwards in time it is necessary to select a departure or benchmark year. Frankema and Jerven (2014) use the 1901 census given that, according to them, it is "the first [census] that covers the 20th century boundaries of Algeria, including the Southern parts of the country."[17] They rely on Fargues (1986) to determine census reliability; however, they neglect additional sources that argue that the 1906 census is more accurate given that its administrative boundaries are significantly different to those reported in 1901 (Bernard, 1908) and that the census-counting was finally centralized (Kateb, 1998, 2004).

There is also disagreement with respect to the total initial population values and growth rates. The 1872 census reports that Muslim population was 2.1 million approximately and that it accounted for almost 90 percent of the total population. As Good (1961) explains, only after the 1870s it experienced a continuous positive growth explained by its natural increase. However, there is no consensus on the real figures for this period. Good (1961) and Yacono (1993) show that the Muslim population in the 1870s was still below 2.5 million and only after 1886 the 3 million figure was surpassed, thus leading to an annual growth rate above 3 percent between 1872 and 1876. In contrast, Frankema and Jerven (2014) show that the 1872 total population had already reached 3.5 million; hence, this means that the Muslim population averaged at least 3 million (as it accounted for almost 90 percent of the total population), thus leading to an annual growth rate of around 1 percent.

With regards to the 1872 Muslim population figures, it seems logical to expect a higher value than the one reported in the 1872 census, and thus, a growth rate below 3 percent. Indeed Kateb (2001, p. 119)

[17] They point out the existence of "more or less pre-1950 figures" and question Manning's assumption regarding the accuracy of the 1950 conventional benchmark. By way of illustration, the authors – based on the Kenya, Nigeria and the Gold Coast – find that the 1950 estimate for total Africa should be adjusted upwards in 20 millions.

Table D.1: Population density in square kilometres (rough estimates): S. Africa, S. Rhodesia, Kenya, and N. Algeria

	S. Africa		S. Rhodesia		Kenya		N. Algeria	
	1800	1962	1900	1962	1900	1960	1830	1954
Pop. density	1.2	15	1.3	8.5	6.9-9.4	14.5	13.8-18.4	39.5
Pop./ Cult.Area	1.9		2.2		22.9-28.6		40.0-50.0	

Source: Lützelschwab (2000, p. 10)

argues that any demography expert would deny the 3.8 percent rate inferred for the 1870s from the 1872 and 1876 censuses following a 10 years demographic crisis. This period, particularly severe between 1861 and 1872, is described by Yacono (1993, p. 169) as *les années terribles* as a result of epidemics (two of cholera, one of typhus, and one of smallpox), drought, famine, and a major rebellion in the Kabylia region. In fact, Good (1961) shows that the municipal Muslim inter-census growth rates turned negative in 1861 and reached a -3.7 percent value between 1866 and 1872. Hence, such a strong negative impact on population should gradually recover, thus not allowing for such an immediate high growth rate.[18] On the other side, a uniform 1 percent growth rate between 1856 and 1901 such as the one applied by Frankema and Jerven (2014) is not plausible either since the negative shock impeded a steady growth throughout all years. This 1 percent value is a proxy used by Frankema and Jerven (2014) that corresponds to the lowest growth rate figures found in Indonesia and the Philippines.[19] The authors argue that South Asian growth rates, reflected by land abundant "open land frontiers," work as better proxies in contrast to the densely populated Indian proxy used by (Manning, 2010).[20] Nonetheless, by the 1870s the frontier and arable land were quasi-exhausted in Algeria (see Chapter 3) and population densities were relatively high (see Table D.1).[21] As an illustration, in the sample used by Acemoglu et al. (2002) in their "Reversal of Fortune" paper,[22] Algeria (together with India, Morocco, and Egypt) is one of the 14 countries (out of a total of 91) exceeding the mean value with regards to the total population relative to arable land,[23] while Indonesia and Philippines are situated below the average (although the former is near the average). Thus, it seems logical to expect total values below the ones provided by Manning (2010) but higher than those used by Frankema and Jerven (2014).

[18] Furthermore, even if the population did recover by 1869 and achieve 3.7 percent growth rate between 1872 and 1876, this recovery was interrupted by the 1871 Kabylia conflict (Yacono, 1993).

[19] Adjusted with additional information on fertility, mortality and marriages.

[20] Frankema and Jerven (2014) also stand against the assumption taken by Manning (2010) that allows using Indian growth rates as proxies for African growth. Given that there is no evidence supporting the similarity between Indian and African conditions (such as labor-to-land ratio), they argue that the growth rates from tropical areas should not be applied to non-tropical regions such as North Africa and South Africa. In their opinion, the African growth rates are not lower than the Indian ones, arguing against Manning's claim "that growth-impeding factors in Africa have been much more severe than in India" (p. 21). As explained by Frankema and Jerven (2014),

> Instead of applying "modified" Indian growth rates (Manning, 2010) we derive growth rates for North Africa (Egypt, Tunisia, Algeria, Libya, Morocco and Spanish Sahara) from the available population censuses of the two most populous countries in the region, Egypt and Algeria. We adopt Egypt as the standard for Libya, and Algeria as the standard for Tunisia, Morocco and Spanish Sahara. We take the first reasonably complete population count as a starting point for backward projections, based on a higher default growth rate (one percent). We end up with a total population estimate for North Africa in 1850 that is ca. 48 percent lower than Manning's estimate (12.8 versus 24.6 million).

[21] Within Northern Algeria, which covered about 210,000 square kilometers, it was estimated that the cultivable share was around 28 percent in 1917 (58,600 square kilometers) (Ageron, 1968).

[22] Based on McEvedy et al. (1978).

[23] Population density is the logarithm of the total population divided by total arable land.

Census Data and Population in Algeria

In order to measure population levels and growth rates from census data, it is important to consider whether the numbers are accurately reported and, if possible, to infer growth rates from at least two reliable censuses that allow for comparison (Frankema and Jerven, 2014).[24] This part follows research undertaken by demographers such as Kamel Kateb, Philippe Fargues, Dorothy Good, and Mahfoud Biraben, and also relies on the 1948 census (as it includes an overview of all the prior censuses) and several ASF ,[25] to estimate both the indigenous and settler population between 1872 and First World War.

Since the late 1850s, Algeria has published censuses every five years; more specifically, nineteen between 1830 and 1962.[26] Although the census-taking dates followed the same dates as those applied in France, the methodology was criticized as it did not adjust to Algerian local features, leading to numerous counting mistakes (particularly because of nomadic population). Prior to the 1900s, the total population series – complemented with natural growth rates – built from quinquennial censuses shows strong changes in levels prior to 1906 that are entirely explained by the Muslim population figures (see Figure D.5). Kateb (2004) explains that, despite numerous initiatives undertaken by the French administration in the 1870s to improve the demographic statistics (such as the creation of a statistical body separated from the government), the counting of the Muslim population encountered several problems. For instance, in the military areas the indigenous population was inferred by counting the number of tents and assuming that each was occupied from five to seven people. In addition, the census-taking time-span lasted several months, leading to double counting and omissions errors.[27] The accuracy of comparison between census improves significantly between 1901 and 1936 as area boundaries are finally established and the census-taking techniques adapt better to local Algerian characteristics (Kateb, 1998, 2004). Indeed, the 1948 census states that any study analyzing the long-term trends of Muslim population must not rely on data collected before 1901 or 1906.[28] However, as Bernard (1908) explains, the 1901 and 1906 censuses hold strong differences given that the latter increased the territorial coverage and thus experienced significant administrative changes. Thus, although these changes covered scarcely populated areas, the 1906 census is more accurate in terms of comparison with the 1948 census. In addition, it is when census-counting is centralized and a *Service de la Statistique Génerale* was in charge of collecting and gathering information for the whole territory and publish them regularly in the *Statistique Générale de l'Algérie* (or SGA)

[24] It is crucial to answer the following question posed by Frankema and Jerven (2014, p. 8): "when does the demographic recording become sufficiently valid to yield reliable level estimates and sufficiently consistent to yield reliable annual growth rates?"

[25] The ASF contain a special section on Algeria. It includes a portion of the census data but it is not as complete as the original census. Regarding censuses from the Gallica webpage, I downloaded the statistics from the SGA, containing the annex of different Algerian census information (although incomplete). I have also been working with the 1948 and 1954 (volume 2 and 3) censuses which are available at the INE in Madrid.

[26] The first population follow up was undertaken by the military administration after 1836, but was limited to Europeans in the occupied cities. However, some estimates for indigenous population were elaborated in 1844, 1856 and 1866 but these were restricted to Algerian populations located within the regions under military administration (Kateb, 1998). In 1856 both indigenous and settlers are finally reported in the territory under military and civil administration (Kateb, 2004). The collected data allow to account for different groups – usually reported as Europeans, Muslims, and Israelites – and their territorial distribution.

[27] Improving in 1886 when the *jour fix* system (one day elaboration) was implemented (Except for the CI and CM). However, it was very inaccurate as it frequently relied on illiterate population to undertake the counting (Kateb, 1998).

[28] Only after 1906 the census data is also provided at a sub-municipal level in *centres*, *douars*, *sections*, etc.

(Kateb, 2004). This is why this section uses the 1906 census to infer population backwards.

To estimate population I first correct the indigenous population series and then aggregate both groups to obtain total population.[29] More specifically, I correct the indigenous natural growth rates between 1872 and 1906 and use the latter to infer the population backwards from 1906. The final series that appears in Figure D.4 (called *Pt_Census_VR_Corrected_LM*) shows that the initial total population growth rate ranged around 0.25 percent and that the initial population was approximately 4 million in 1872, thus standing between Manning's (2010) estimates and Frankema and Jerven's estimates.

Table D.2 provides the descriptive statistics about total population, births, deaths, and migration.[30] Graph D.6 shows the difference between the corrected natural growth series (NG) – that is, total births minus total deaths – before 1906 and the reported one by censuses. Graph D.7 shows the Muslim population corrected growth rates and Frankema-Jerven's (2014) total population growth rate.[31] What follows explains both the corrections in the indigenous birth and death rates, and potential bias in the data used.

With respect to indigenous total births, the series reported in censuses has 47 observations starting in 1879.[32] I first calculated an *Interpolated* series by geometrically interpolating the missing observations between the available years and 1879. To go backwards up to 1872, I assigned to 1872 and 1876 the same birth rate (25.67) as the one reported in the 1881 census, and then interpolated the missing years. After this, given that it has been proven that censuses are significantly underestimated, I calculated a *Corrected* series. According to Kateb (2001) and Biraben (1969), prior to the 1880s there are only a few vital rate estimates that are considered to be reliable. These are for the year 1876 and are based on a small sample of 145 municipalities, representing approximately 1,100,438 inhabitants (almost 45 percent of the Muslim population).[33] Thus, I apply this value (37.3 per thousand inhabitants) to 1876, leading to a 45 percent higher number of births than the one inferred from census observations. Given that Biraben's (1969) corrected birth rate series begins in 1876 (one value for each census), I also assigned the 37.3 value to 1872 and interpolated the missing values in-between. Following this, I adjusted the rest of the series prior to 1906 applying Biraben's (1969) improved birth rates that takes into consideration registration omission (based on Breil (1954)).[34] However, his corrections are not available for 1881 and 1886. Thus, I corrected these missing birth rates by adjusting the average underestimation (i.e., the mean difference

[29] I proxy the settler group with the census-reported non-Muslim group and the indigenous one by the Muslim group.

[30] In the original series, European and Israelites births and deaths are available from 1873 to 1937 with six missing observations, while Muslim births and deaths, from 1879 to 1936, have twelve missing observations.

[31] Notes on vital rates. Between 1872 and 1878 the military deaths have been subtracted from data, but after 1879 they are separately counted from the death data, so it is possible to exclude them. Thus, I have excluded them from the series. Stillbirths are more complicated to measure due to data lack of data. For Muslim and non-Muslim births, it has been possible to account for stillbirths and exclude them from the series (except for the period 1873-1875 where they are included both in births and deaths series) and they have also been excluded from the death series.

[32] Between 1872 and 1936 there are 11 missing observations. The value in 1880 is the average between 1879-1881, 1885 is the average between 1885 and 1887. Stillbirths (*mortnés et mort avants la déclaration de naissance*) are excluded.

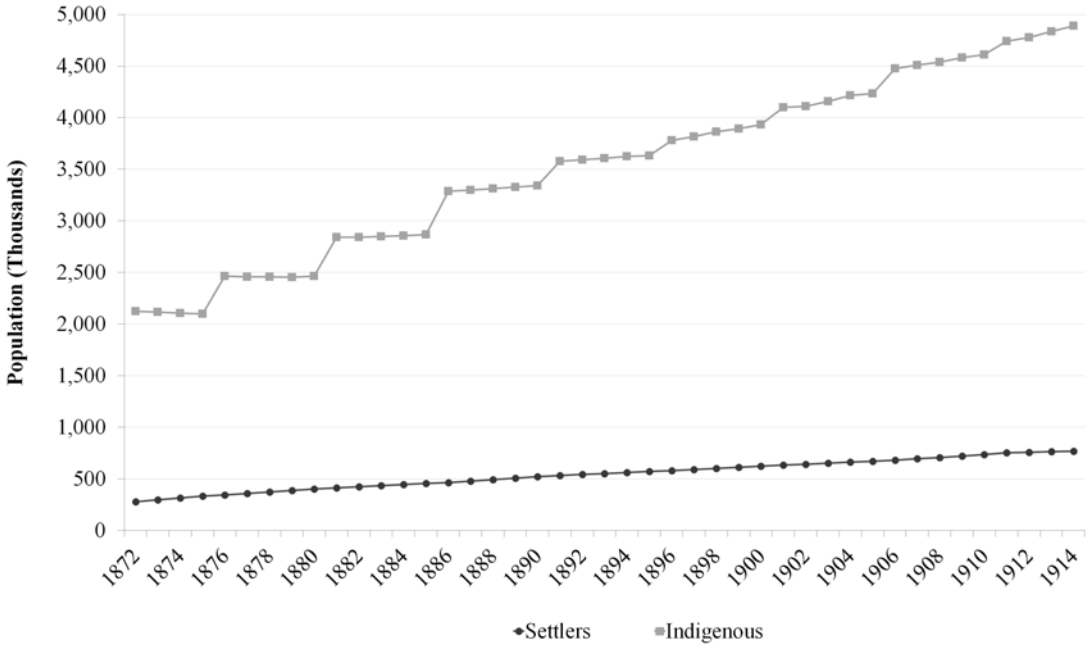
[33] Still, it is also found to be underestimated (Kateb, 2004). However, it is considered to be reliable due to a decree issued in 1875 that penalized omission or late submission of birth and death declarations according to the *Code Pénal* (Biraben, 1969, p. 713).

[34] The values after 1900 are also underestimated after 1900 but this section only corrects the ones before 1900. According to the authors, between 1891 and 1913 the underestimation averages 25 percent and then, up to 1921, it increases to 34 percent (Kateb, 2001).

between Biraben's birth rates and the census ones) to its corresponding census birth rate value (obtaining a 35.03 in 1881 and a 35.07 in 1886). Finally, I completed the *Corrected* series for the years prior to 1906 by adjusting the *Interpolated* series to the corrected birth rates.

The total deaths series must be tackled with more care (Negadi et al., 1974). According to Kateb (2001), there is no consensus on the deviations from real values. Although a majority of authors, such as Vallin (1975) or Biraben (1969), find that mortality figures are underestimated, others, like Fargues (1986), find that the reported figures are overestimated, hiding an "endogenous" early demographic transition as a result of improved indigenous standards of living (e.g., better infrastructures and vaccines). The death series used in this section has 47 observations starting in 1879.[35] To infer the years before 1906, I first assigned the 32.9 per thousand rate obtained from the 1876 estimation of 145 municipalities (as explained in the paragraph above) to the years 1876 and 1872 and geometrically interpolated the missing values. Based on Negadi et al. (1974), the 1881, 1886, 1891, and 1896 total deaths figures are calculated assuming that mortality underestimation was around 35 percent between 1891 and 1935. I then interpolated the missing values. Finally, the 1901 mortality rate is obtained from Negadi et al. (1974) (and similar to Kateb's (2001) 33.3 value).[36]

Figure D.5: Total indigenous and settler population,[37] French Algeria 1872-1936



Source: *Résultats statistiques du dénombrement de la population effectué le 31 octobre 1948*. For further detail on sources see Appendix D.

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[35] With 11 missing observations after 1879. Stillbirths are excluded after 1894, the problem is that data prior to 1894 for Muslims is very scarce and does not clarify if stillbirths are included. The raw data shows no decreasing tendency but it does show a propensity to stabilize. The three observations corresponding to 1880, 1882 and 1885 are averages to their respective three surrounding years.

[36] In addition, Kateb (2001) calculates some estimates for the mortality rates, resulting in 33.5 per thousand for the years between 1901-1904, 31.7 per thousand for the years between 1905-1909, and 27.8 per thousand for the following five years. He applies the Brass methodology which is an estimation technique used in demography.

[37] The settler category is proxied by the non-Muslim group while the indigenous population is proxied by the reported Muslim category. See section on terminology in the Introduction for more detail.

Table D.2: Summary statistics in Appendix D

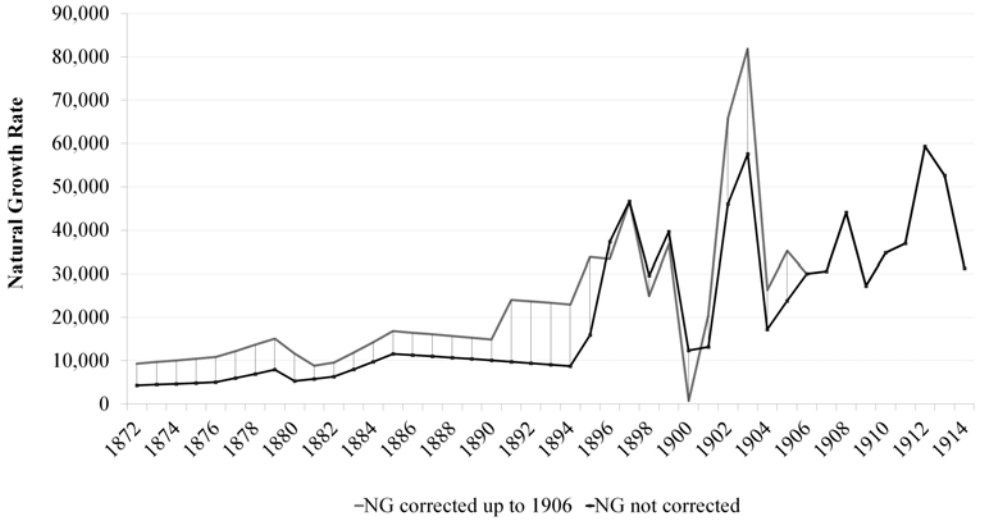
Variable	Mean	Std. Dev.	N
Total Census Population	4,781,641	1,460,073	13
Total Census Muslim Population	4,096,594	1,230,242	13
Muslims Births	129,480	35,575	47
Muslims Deaths	90,933	14,417	47
Muslim Stillbirths	1,503	328	44
Total Census non-Muslim Population	636,374	207,733	14
European and Israelites Births	18,555.10	2,866	58
European and Israelites Deaths	12,750	1,283	58
Stillbirths_Eur & Isr	703	92	50
Total Census Population "Corrected"	4,511,507	646,039	65

Source: Annual *Annuaire Statistique de la France* (ASF), see text for more detail.

However, despite these corrections, the population figures must be regarded with caution as Algerian census periodicity and regularity responded to colonial policy priorities: that is, establishing a settlement colony by increasing French population. The French demographical statistical body was influenced by the colonial policy whose initial aim, aside from tax purposes, was to inform the *métropole* about the progress of colonization and prove that settlement was successful (Kateb, 2004). Thus, the European numbers were many times inflated; for example, the 1931 and 1936 censuses were exaggerated because of the naturalizations (granting French nationality) undertaken by the French government to decrease concerns over the fall in French numbers (Kateb, 1998).[38] Indeed, this was a regular behavior across colonizing countries; for instance, Frankema and Jerven (2014) explain that French West Africa and French Equatorial Africa inflated numbers for fiscal and commercial interests towards Paris. In addition, as Fetter (1987) argues for the Belgian Congo, Northern Rhodesia, and Nyasaland , the population is often under-counted as respondents avoided colonial officers and administrators due to tax collection. Thus, while indigenous populations were clearly underestimated in census counting mostly because of nomadic populations or tax incentives, the settler population was often inflated.

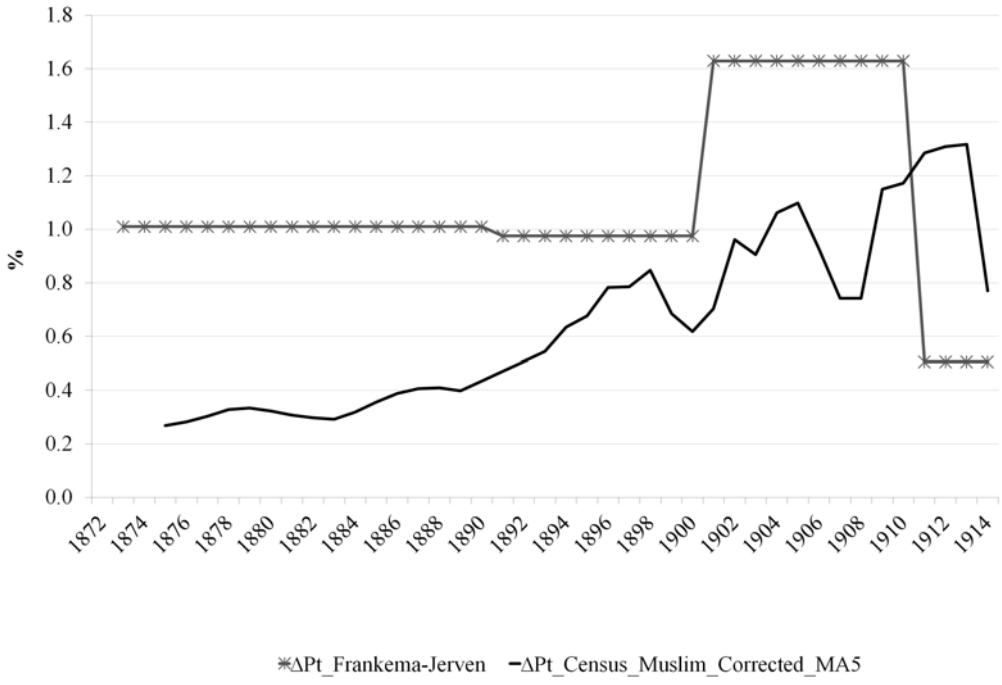
[38]The Sénatus-Consulte of 14th of July 1865 was the first legal procedure granting French citizenship to foreigners having completed three years of residence in Algeria. The second procedure was applied in 1889 giving automatically citizenship to children with foreign parents who were born within Algerian borders and did not reject it. The Jewish population was granted French citizenship with the *Crémieux* decree in 1870 (Kateb, 1998).

Figure D.6: Natural population growth rates, French Algeria 1872-1914



Source: Annual *Annuaire Statistique de la France* (ASF), see text for more detail.

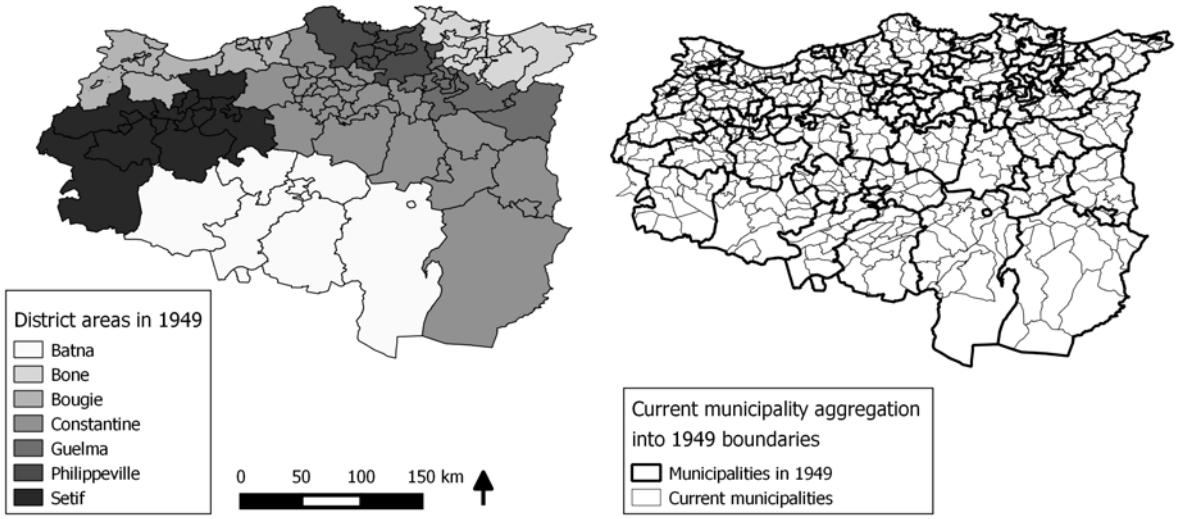
Figure D.7: Muslim and total population growth, Algeria 1872-1914



Source: Annual *Annuaire Statistique de la France* (ASF), see text for more detail.

D.5 Spatial Aggregation and Changes in Administrative Names

Figure D.8: Aggregating current municipalities into 1949 boundaries in Constantine



The final dataset does not include areas such as Khenchela or Tébessa (the two big municipalites in the South-Eastern part) since their boundaries changed significantly between 1902 and 1939/49. *Source*: *Carte des Limites Administratives, Departement de Constantine, Gouvernement Général de l'Algérie* (1939, 1949). For GIS current administrative boundaries I used Global Administrative Areas (2012). GADM database of Global Administrative Areas, version 2.0. [online] URL: www.gadm.org. See Appendix D for more detail on sources.

This section provides a detailed description on the aggregation of the current municipalities in order to construct the old municipalities included in the dataset. For example, in Constantine, the old municipality named *Aïn Beïda_pe* is a *commune de plein exercice* (with the extension "_pe") and is formed by part of present Fkirina and a portion of current Aïn Beïda, while *Aïn M'Lila_m* is a *commune mixte* (with the extension "_m") is formed by a portion of the current Aïn Beïda, a part of Oued Seguen, and 12 current municipalities.

Constantine. COMMUNES DE PLEIN EXERCICE- Constantine_pe: Constantine. Aïn Abid_pe: part of Ain Abid. Aïn Beïda_pe: part of Fkirina and part of Ain Beida. Aïn Kerma_pe: Boudjeriou Messaoud. Aïn Smara_pe: part of Ain Semara. Aïn Tinn_pe: part of Sidi Khelifa, part of Ain Mellouk, and Ain Tine. Bizot_pe: Beni Hamidene and Didush Murad. Condé Smendou_pe: Zighoud Youcef and part of Ouled Hebbaba. Grarem_pe: part of Grarem Gouga,Hamala, and part of Cheraga. Guettar El Aiech_pe: part of Constantine and part of El Khroub. Hamma_pe: Hamma Bouziane. El Khroub_pe: part of El Khroub and Ben Badis. Mila_pe: part of Zeghaia, part of Sidi Khelifa, Mila, and part of Ahmed Rachedi. Oued Athmenia_pe: part of Teleghma, part of Chelghoum Laid, and part of Oued Seguen. Oued Seguin_pe: part of Teleghma, part of Ain Semara, and part of Oued Seguen. Oued Zenati_pe: Ain Rekada, Oued Zenati, Ras El Agba, part of Bordj Sebbat, and part of Tamlouka. Ouled Rahmoun_pe: Ouled Rahmoune. Renier_pe: part of Ain Makhlouf. Rouffach_pe: Ibn Ziad. Sidi Merouane_pe: part of Cheraga and Sidi Merouane. Tébessa_pe: part of Boulhaf Dyr, part of El Kouif, and part of Tebessa. Zeraia_pe: part of Zeghaia and Oued Endja. COMMUNES MIXTES- Aïn M'lila_m: part of Ain Abid, Ain El Kercha, Ain

M'Lila, El Amiria, Hanchir Toumghani, Ouled Gacem, Ouled Hamla, Sigous, Souk Naamane, Ain El Fakroun, part of Oued Seguen, El Fedjoudj Boughrara Saoudi, El Harmilia, and Ouled Zaoui. Chateaudun du Rummel_m: part of Teleghma, Benyahia Abderrahmane, part of Chelghoum Laid, part of Oued Athmenia, part of Tadjenanet, El Mechira, Bir Chouhada, Ouled Khelouf, and part of Ain Mellouk. In the map there is a commune de plein exercice named Chateaudun du Rummel (which was created the 15th of October 1921), but in the period under study it was still classified as commune mixte. Hence, the commune de plein exercice in the map is included within the commune mixte area. El Milia_m: Bouraoui Belhadef, El Ancer, El Milia, Ghebala, Kheir Oued Adjoul, Ouled Rabah, Ouled Yahia Khadrouche, Settara, Sidi Marouf, and part of Grarem Gouga. Fedj M'zala_m: part of Ahmed Rachedi, Ain Beida Harriche, Amirat Arres, Bouhatem, Derradji Bousselah, Elayadi Barbes, Ferdjioua, Minar Zarza, Rouached, Tassadane Haddada, Terrai Bainnane, Tessala Lamtai, Tiberguent, Yahia Beniguecha, part of Bellaa, Djemila, Tachouda, and part of Ain Mellouk. Meskiana_m: Ain Touila, Belala, Bhir El Chergui, El Dhaala, El Djazia, El Rahia, Meskiana, Oued Nini, part of El Ouinet, part of Berriche, part of Fkirina, and Zorg. Morsott_m: Ain Zerga, Bekkaria, Bir Dheb, Boukhadra, El Meridj, Hammamet, Morsot, Ouenza, part of El Ouinet, part of Boulhaf Dyr, and part of El Kouif. The commune mixte of Morsott (created the 29th of December 1884) was previously known as the commune mixte of Tébessa. This study maintains the name Morsott. Oum el Bouaghi_m: Ksar El Sbihi, Ain Zitoun, Oum El Bouaghi, part of Berriche, Ain Bebouche, Ain El Diss, part of Ain Beida, part of Tamlouka, and part of Fkirina. Sedrata_m: Bir Bouhouche, Khemissa, M'Daourouche, Oued Kebrit, Oum El Adhaim, Ragouba, Safel El Ouiden, Sedrata, Terraguelt, and Zouabi. Tébessa_m: Bedjene, Bir El Ater, Chrea, El Houidjbet, El Malabiodh, El Mezeraa, El Ogla, Ferkane, Negrine, Ogla Melha, Oum Ali, Safsaf El Ouesra, Stah Guentis, Thelidjene, Bir Mokadem, Gourigueur, and part of Tebessa.

Creation date according to Tableau général des communes 1902- Constantine_pe: 26th of April 1854; Aïn Abid_pe: 25th of August 1885; Aïn Beïïda_pe: 10th of December; Aïn Kerma_pe: 28th of July 1885; Aïn Smara_pe: 8th of October 1869; Aïn Tinn_pe: 23rd of November1880; Bizot_pe: 10th of August 1868; Condé Smendou_pe: 22nd of August 1861; Grarem_pe: 9th of April 1888; Guettar El Aiech_pe: 5th of December 1877; Hamma_pe: 10th of December 1866; El Khroub_pe: 28th of March 1863; Mila_pe: 23rd November 1880; Oued Athmenia_pe: 10th of December 1868; Oued Seguin_pe: 8th of March 1874; Oued Zenati_pe: 10th of December 1868 and 3rd of February 1896; Ouled Rahmoun_pe: 8th of October 1869; Renier_pe: 3rd of February 1896; Rouffach_pe: 7th of March 1874; Sidi Merouane_pe: 23rd of November 1880; Tébessa_pe: 4th of December 1880; Zeraia_pe: 23rd of November 1880; Aïn M'lila_m: 28th of November 1874; Chateaudun du Rummel_m: 7th of November 1874; El Milia_m: 25th of August 1880; Fedj M'zala_m: 1er of December 1880; Meskiana_m: 21st of December 1880; Morsott_m: 29th of December 1884; Oum el Bouaghi_m: 21st of December 1880; Sedrata_m: 21st of December 1880.

Batna. COMMUNES DE PLEIN EXERCICE- Batna_pe: part of Tazoult, part of Batna, and Fesdis; Biskra_pe: Biskra; Lambèse_pe: part of Tazoult; Khenchela_pe: The commune de plein exercice of Khenchela appears the 20th of March 1911; hence, in this study it is included within the commune mixte of Khenchela. COMMUNES MIXTES- Aïn el Ksar_m: Ain Yagout, Boulhilat, Boumia, Chemora, Djerma, El Madher, Lazrou, Ouled Fadhel, Seriana, Timgad, and part of Ouyoun El Assafir; Aïn Touta_m: Ain Touta, Beni Foudala El Hakania, Maafa, Oued Chaaba, Ouled Aouf, Tilatou, Ain Zaatout, Branis, Djamora, El Kentara, El Ouitaya, and part of Batna; Aurés_m: Arris, Bouzina, Chir, Foum Toub, Ghessira, Ichmoul, Inoughissen, Kimmel, Larbaa, Menaa, Oued Taga, part of Ouyoun El Assafir, T Kout, part of Tazoult, Teniet El Abed, Tighanimine, Tigharghar, M_Ziraa, Mechouneche; Khenchela_m: Babar, Baghai, Bouhmama, Chechar, Chelia, Djellal, El Mahmal, El Oueldja, Kais, Khirane, M'Sara, M'Toussa, Ouled Rechache, Remila, Tamza, Taouzianat, Yabous, Khenguet Sidi Nadji, El Hamma, Ensigha and Khenchela; Ouled Soltan_m: the 5th of October 1907 the lands of the commune mixte Ouled Soltan were distributed among the commune mixtes of Aïn Touta, Barika and Belezma. For this reason it will only be included in the sample if comparing time changes; Belezma_m: part of Ain Azel, Ain Djasser, El Hassi, Guiga, Hidoussa, Ksar Bellezma, Lemsane, Merouana, Oued El Ma, Ouled Sellem, Ras El Aioun, Rehbat, Talkhamt, Taxlent, and Zanet El

Beida; The commune mixte of Belezma was originated the 27th of September 1904 from territories belonging to the communes mixte Aïn El Ksar, d'Aïn Touta, and Ouled Soltan; So it is not possible to account for this municipality to analyze time variation; Barika_m: Ain Khadra, Belaiba, Berhoum, Dehahna, Magra, Azil Abdelkader (Metkouak), Barika, Bitam, Boumegueur, Djezzar, Gosbat, M'Doukal, N'Gaous, Ouled Ammar, Ouled Si Slimane, Sefiane, and Seggana. It was created the 5th of October 1907 parts of the *commune indigène* of Barika and parts of the *commune mixte* Ouled Soltan.

Creation date and 'type' according to Tableau général des communes 1902- Batna_pe: 18th of February 1860; Biskra_pe: 22nd of May 1878 and the 2nd of August 1892; Lambèse_pe: 8th of October 1869; Aïn el Ksar_m: 29th of December 1884; Aïn Touta_m: 29th of December 1884; Aurés_m: 18th of December 1886. The dataset contains two additional communes mixtes created during the period under study: Ouled Soltan and Belezma. Barika_m: 5th of October 1907.

Bône. COMMUNES DE PLEIN EXERCICE- Bône_pe: Annaba and part of El Bouni; Aïn Mokra_pe: part of Berrahal, part of Oued El Aneb, and part of Treat; Barral_pe: part of Chihani; Bugeaud_pe: part of Seraidi; Duvivier_pe: part of Oued Fragha, part of Bouchekouf, and part of Medjaz Sfa; Duzerville_pe: Sidi Amar, part of Chorfa, El Hadjar, and part of Chebaita Mokhtar; Herbillon_pe: part of Chetaibi, and part of El Marsa; La Calle_pe: part of El Kala and part of Souarekh; Mondovi_pe: part of Chebaita Mokhtar and Drean; Morris_pe: part of Ben M'Hidi and Zerizer; Nechmeya_pe: Nechemaya; Penthièvre_pe: Ain El Berda; Randon_pe: Echatt, Besbes, and part of El Bouni; Randon_pe: Echatt, Besbes, and part of El Bouni. COMMUNES MIXTES- Beni salah_m: Beni Salah (previously known as the commune mixte of Zerizer) was suppressed the 26th of January 1909 so this study aggregates the data of Beni Salah to the data of the commune mixte of Edough assuming that the map already includes the Beni Salah within Edough; Edough_m: part of El Marsa, part of Berrahal, part of Chetaibi, part of Oued El Aneb, part of El Bouni, part of Seraidi, part of Treat, part of Chetaibi, and Ben Azzouz //part of Chorfa and El Eulma//part of Oued Fragha, Ain Ben Beida, and part of Bouchekouf//Hammam Ben Salah, Ben M'Hidi, part of Medjaz Sfa, part of Chihani, part of Bouchekouf, part of Oued Fragha, Asfour, and Chefia; La Calle_m: Ain El Assel, Ain Kerma, Berrihane, Bougous, Bouteldja, El Aioun, part of El Kala, El Tarf, Lac Des Oiseaux, Raml Souk, Zitouna, part of Souarekh, Oued Zitoun, part of Ouled Driss, and Bouhadjar.

Creation date according to Tableau général des communes 1902- Bône_pe: 31st of January 1848; Aïn Mokra_pe: 10th of December 1868; Barral_pe: 7th of November 1870; Bugeaud_pe: 22nd of August 1861; Duvivier_pe: 22nd of August 1861; Duzerville_pe: 22nd of August 1861; Herbillon_pe: 10th of December 1869 and 3rd of September 1889; La Calle_pe: 31st of December 1836; Mondovi_pe: 22nd August 1861; Morris_pe: 22nd of May 1885; Nechmeya_pe: 7th of November 1870; Penthièvre_pe: 22nd of August 1861 and 4th of September 1891; Randon_pe: 10th of December 1868; Beni salah_m: 13th of April 1876; Edough_m: 29th of December 1884; La Calle_m: 29th of December 1884.

Bougie. COMMUNES DE PLEIN EXERCICE- Bougie_pe: part of Bejaia; Akbou_pe: part of Akbou; Chekfa_pe: part of Chekfa; Djidjelli_pe: part of Jijel; Duquesne_pe: part of el Aouana, part of Jijel, and Kouas; El Kseur_pe: part of El Kseur, part of Tinedbar, and part of Ifelain Ilmathen; Oued Amizour_pe: part of Amizour, part of Smaoun, and part of Timezrit; Strasbourg_pe: part of Emir Abdelkader. COMMUNES MIXTES- Akbou_m: part of current Akbou, Chellata, Ighrem, Beni-Mellikeche, Bouhamza, Tamokra, Amalou , part of Sidi Said, part of Boudjellil, part of Ait R'Zine, part of Tazmalt, Ighil-Ali, Ouzzelaguen, part of Seddouk, and Tazmalt. Seddouk, which appears in the historical administrative organization in the 1949 map and not in the historical dataset, was a population centre (centre de population) created in 1872 and became a *commune de plein exercice* the 12th of August 1928. Tazmalt was created in 1872 and became a *commune de plein exercice* the 10th of July 1925. Hence, making a judgement call, it will be included within the *commune mixte* of Akbou; Guergour_m: Ain-Legradj, Beni-Mouhli, Beni-Ouartilane, Beni Chebana, Bougaa, Bousselam, Draa-Kebila, Hammam Guergour, Harbil, Maouaklane, Tala-Ifacene, Benimaouche, part of Draa El Caid, part of Bouandas, Ain-Legradj, Guenzet Tassameurt,

part of Ain Roua, and part of Beni Oussine; Oued Marsa_m: part of current Babor, Melbou, Tamridjet, Aokas, Souk El Tenine, Ait-Smail, Boukhlifa, Taskriout, Tichy, Tizi-N'Berber, Kendira, Ait-Tizi, Ait Naoual Mezada, part of Darguina, and Bouandas; Soummam_m: Adekar, Beni Dejllil, Beni K'Sila, Berbacha, El Kseur, Feraoun, Oued Ghir, Tala Hamza, Taourit Ighil, Toudja, part of Bejaia, part of Timezrit, part of Smaoun, Amizour, Akfadou, Chemini, Souk Oufella, part of Ifelain Ilmathen, part of Tinebdar, part of Sidi Said, and Tifra; Taher_m: Bordj Tahar, Boussif Ouled Askeur, Chahna, Djemaa Beni Habibi, El Kennar Nouchfi, Sidi Abdelaziz, part of Chekfa, part of Oudjana, part of Emir Abdelkader, and part of Emir Abdelkader; Djidjelli_m: Boudria Beniyadjis, Djemila, El Aouana, Erraguene, Selma Benziada, Texenna, Djidjelli and Oudjana. The *commune mixte* Tababort appears in the historical 1949 map but not in the dataset. This is because in 1906 the *commune mixte* Tababort is named Djidjelli (the 5th of October 1906). Therefore, in this paper, the 1904 *commune* Tababort will be changed to Djidjelli to homogeneise the dataset. *Creation date according to Tableau général des communes 1902*- Bougie_pe: 17th of June 1854; Akbou_pe: 20th of March 1883; Chekfa_pe: 30th of January 1897; Djidjelli_pe: 18th of February 1860; Duquesne_pe: 25th of February 1879; El Kseur_pe: 1st of December 1879; Oued Amizour_pe: 23rd of July 1878; Strasbourg_pe: 29th of March 1880; Akbou_m: 1st of December 1880; Guergour_m: 1st of December 1880; Oued Marsa_m: 25 of August 1880; Soummam_m: 25th of August 1880; Taher_m: 25th of August 1880; Djidjelli_m: (Tababort_m): 25th of August 1880.

Guelma. COMMUNES DE PLEIN EXERCICE- Guelma_pe: part of Ben Djerrah, part of Belkheir, part of Medjaz Ammar, and Guelma; Clauzel_pe: part of Ben Djerrah, Hammam Debagh, part of Houari Boumediene, part of Medjaz Ammar, and part of Selaoua Announa; Enchir Saïd_pe: Bouati Mahmoud; Enchir Saïd after the 29th of January 1921 is named Galliéni, which is the *commune* that appears in the map. This study will maintain the name of Enchir Saïd for that same *commune*; Guelaa Bou Sba_pe: Kalaat Bousbaa; Heliopolis_pe: Helliopolis; Kellermann_pe: El Fedjoudj and part of Medjaz Ammar; Millesimo_pe: part of Belkheir; Petit_pe: Boumahra Ahmed and part of Djebala El Khemissi; Souk Ahras_pe: Souk Ahras. COMMUNE MIXTES- Oued Cherf_m: part of Bordj Sebbat, part of Bou Hamdane, part of Ain Makhlouf, Ain Larbi, part of Houari Boumediene, part of Selaoua Announa, part of Ben Djerrah, Ain Soltane, part of Khezzara, part of Ain Sandel; Séfia_m: Beni Mezline, Bou Hachana, Dahouara, Hammam N'Bail, part of Khezzara, Oued Cheham, Hanencha, Machroha, part of Djebala El Khemissi, part of Ain Sandel, part of Bouchekouf, part of Medjaz Sfa, and part of Ouled Driss; Souk Ahras_m: Ain Zana, Drea, Haddada, Khedara, Merahna, Ouled Moumen, Sidi Fredj, Taoura, Tiffech, Zaarouria, Ouillen, and part of Ouled Driss; *Creation date according to Tableau général des communes 1902*- Guelma_pe: 17th of June 1854; Clauzel_pe: 18th of March 1874; Enchir Saïd_pe: 10th of December 1868 and 23rd of February 1887; Guelaa Bou Sba_pe: 5th of July 1875; Heliopolis_pe: 10th of December 1868; Kellermann_pe: 12th of July 1886; Millesimo_pe: 10th of July 1868; Petit_pe: 15th of March 1877; Souk Ahras_pe: 22nd of August 1861; Oued Cherf_m: 5th of April and 16th of September 1876; Séfia_m: 1er of December 1880; Souk Ahras_m: 29th of December 1884.

Sétif. COMMUNES DE PLEIN EXERCICE- Sétif_pe: part of Mezloug, part of Ain Arnat, and Setif; Aïn Abessa_pe: Aïn Abessa and part of Ain Arnat; Aïn Roua_pe: part of Aïn Roua; Aïn Taghrout_pe: part of Ain Taghrout, part of Ain Tesra, part of Bir Kasdali, and part of Tixter. Aïn Taghrout became a *commune de plein exercice* in 1880 but expanded in 1907. Still, comparing the area in the 1902 *Tableau* (134.97 km2) with the one corresponding to 1939/49 (around 170km2), it is possible to see that the difference is not very significant. Therefore, despite the expansion, this paper sticks to the 1939/49 boundaries; Bordj Bou Arréridj_pe: part of Bordj Bou Arreridj and Hasnaoua; Coligny_pe: part of Ain Arnat, part of Mezloug, and part of Tixter; El Ouricia_pe: El Ouricia; Saint Arnaud_pe: part of Beni Fouda, part of El Eulma, and part of Guelta Zerka; Tocqueville_pe: part of Ras El Oued. It became a *commune de plein exercice* the 16th of March 1912. Tocqueville (*centre and farms*) was located in 1902 in the *commune mixte Rhira* (by *Arrêté gouvernemental* the 7th of March 1881) so it will be aggregated in the latter. COMMUNES MIXTES- Bibans_m: Bordj Zemoura, Colla, Djaafra, El M'Hir, El Main,

Haraza, Mansoura, Medjana, Ouled Dahmane, Ouled Sidi Brahim, Tafreg, Teniet En Nasr, El Achir, Tesmart, part of Bendaoud, part of El Achir, part of Sidi Embarek, part of Bir Kasdali, and part of Khelil; Eulma_m: Bazer-Sakra, Beidha Bordj, Bir-El-Arch, El Oueldja, Guidjel, Hammam Soukhna, Ouled Saber, Taya, Telaa, part of El Eulma, part of Guelta Zerka, part of Beni Fouda, part of Bellaa, and part of Tadjenanet; Maadid_m: part of Ain Tesra, Belimour, Bordj Ghdir, El Ach, part of El Achir, El Anseur, El Hamadia, Ghilassa, Ksour, Rabta, part of Sidi Embarek, part of Bordj Bou Arreridj , Maadid, Taglait, part of Ras El Oued, and part of M'Sila// Part of Ain Taghrout, part of Khelil, part of Ain Arnat, and part of Beni Oussine; M'Sila_m: part of Bendaoud, part of M'Sila, Beni Ilmane, Hammam Dalaa, M'Tarfa, Ouanougha, Ouled Derradj, Ouled Madhi, Ouled Mansour, Soumaa, Tarmount, Ouled Addi Guebala, Khoubana, M'Cif, and Maarif; Rhira_m: Boutaleb, Hamma, Ouled Si Ahmed, Ouled Tebben, Rosfa, Salah Bey, Ain Oulmane, Bir Haddada, Guellal, Ksar El Abtal, Ain Lahdjar, part of Ain Azel. Both Colbert (*plein exercice*) and Ampère (*plein exercice*), which appear in the map, are not included in the dataset; Colbert became a *commune de plein exercice* the 8th of April of 1932 and Ampère the 12th of April 1922. Both are included in the *commune mixte* Rhira; Takitount_m: Ain-Sebt, Ain El Kebira, Amoucha, Beni-Aziz, Dehamcha, Maaouia, Oued El Barad, Ouled Addouane, Serdj-El-Ghoul, Tizi N'Bechar, part of Darguina, part of Babor, part of Draa El Caid, and Kherrata. What in the map appears to be Kerrata (*commune de plein exercice*) in the dataset it is included within the *commune mixte* of Takitount since it was declared *commune de plein exercice* the 15th of January 1949. *Creation date according to Tableau général des communes 1902*- 17th of June 1854; Aïn Abessa_pe: 25th of February 1879; Aïn Roua_pe: 10th of November 1880; Aïn Taghrout_pe: 27th of December 1880; Bordj Bou Arréridj_pe: 3rd of September 1870; Coligny_pe: 22nd of August 1861 and 25 of February 1899; El Ouricia_pe: 28th of March 1863; Saint Arnaud_pe: 10th of December 1868; Tocqueville_pe: Became a *commune de plein exercice* the 16th of March 1912; Bibans_m: 1st of December 1880; Eulma_m: 7th of November 1874; Maadid_m: 7th of November 1874; M'Sila_m: 29th of September 1884; Rhira_m: 7th of March 1881; Takitount_m: 25th of August 1880 and 19th of February 1902.

Philippeville. COMMUNES DE PLEIN EXERCICE- Philippeville_pe: Skikda, Filfila, Hamadi Krouma, Beni Bechir, part of El Hadaiek and part of Ain Zouit; Col des Oliviers_pe: Ain Bouziane; Collo_pe: Collo; El Harrouch_pe: El Harrouch; Gastonville_pe: Salah Bouchaour; Gastu_pe: part of Ain Charchar and part of Bekkouche Lakhdar; Jemmapes_pe: part of Azzaba; Robertville_pe: Sidi Mezghiche and Emjez Edchich; Saint Charles_pe: Ramdane Djamel; Stora_pe: part of Ain Zouit and part of Skikda; COMMUNES MIXTES- Attia_m: it was attached to the commune mixte of Collo the 16th of December 1905; therefore it is aggregated to the latter; Collo_m: Ain Kechra, Beni Oulbane, Beni Zid, Bin El Ouiden, Bouchetata, Cheraia, part of El Hadaiek, Kanoua, Kerkera, Kheng Maoun, Oued Zhour, Ouldja Boulbalout, Ouled Attia, Oum Toub, Tamalous, and Zitouna; Jemmapes_m: part of Ain Charchar, Djendel Saadi Mohamed, part of Azzaba, Zerdeza, El Ghedir, Es Sebt, part of Bekkouche Lakhdar, Roknia, part of Ouled Hebbaba, and part of Bou Hamdane; Creation date according to Tableau général des communes 1902- Philippeville_pe: 31 of January 1848; Col des Oliviers_pe: 15th of December 1870 and 26th of October 1894; Collo_pe: 5th of November 1880; El Harrouch_pe: 22nd of August 1861; Gastonville_pe: 28th of August 1861; Gastu_pe: 10th of December 1868 and 27th of February 1887; Jemmapes_pe: 31st of December 1856; Robertville_pe: 22nd of August 1861; Saint Charles_pe: 22 of August 1861 and 13th of March 1895; Stora_pe: 15th of December 1870 and 29th of September 1879; Attia_m: 25th of August 1880; Collo_m: 25th of August 1880; Jemmapes_m: 13th of October 1874 and 30th of March 1895.

Table D.3: List of localities of communes or municipalities that changed names, from Archives & Culture (2011, p. XV)

Names before 1962	Actual Commune	Departments in 1958	Wilaya en 1958	Actual Wilaya	Names before 1962	Actual Commune	Departments in 1958	Wilaya en 1958	Actual Wilaya
Aguemoune	Sidi Maouche	Sétif	Bougie	Béjaïa	La Calle	El Kala	Bône	Le Tarf	El Tarf
Ahmed Ben Ali		Const. (en 1876)			La Fayette (1894)	Bougaa	Sétif	Sétif	Sétif
Aïn Mokra	Berrahal	Bône	Bône	Annaba	La Réunion	Oued Ghir	Sétif	Bougie	Béjaïa
Alkirch		Const. (en 1876)			La Roberteau	Essebt	Const.	Philippeville	Skikda
Ampère (1897)	Aïn Azel	Sétif	Sétif	Sétif	La Robertsau (1872)		Const. (en 1876)		
Arago	Bordj Ali	Const. (en 1876)	Djidjelli	Jijel	Lacroix (1890)	El Aioun	Bône	le Tarf	El Tarf
Auguste Comte (1912)	Baghai	Batna	Khenchela	Khenchela	Lambèse	Tazoult	Batna	Batna	Batna
Auribeau (1882)	Ain Cherchar	Const.	Philippeville	Skikda	Lamy (1904)	Bou Hadjar	Bône	Le Tarf	Eltarf
Barral (1848)	Chihani	Bône	Le Tarf	El Tarf	Lannoy (1874)	Djendel	Const.	Philippeville	Skikda
Bayard (1904)	Menzel-Bendiche	Const.	Philippeville	Skikda	Lapaine (1899)	Ben Smih	Bône	Guelma	Guelma
Belfort	Aïn Tine	Const.	Mila	Mila	Laveran (1921)	Sidi Mançar	Batna	Batna	Batna
Beni Mansour	Boudjellil	Sétif	Bougie	Béjaïa	Laverdure (1874)	Mechroha	Bône	Souq Ahras	Souk Ahras
Bernelle	Oued El Ma	Batna	Batna	Batna	Lavoisier (1908)	Ayadat	Sétif	Bordj Bou Arréridj	Bordj Bou Arréridj
Berrahal	Ain Mokra	Bône	Bône	Annaba	Lecourbe (1881)	El Hamadia	Sétif	Bordj Bou Arréridj	Bordj Bou Arréridj
Berteaux (1909)	Ouled Hamla	Batna	Canrobert	Oum El Bouaghi	Les Lacs	Ouled Zouai	Batna	Canrobert	Oum El Bouaghi
Bessombourg (1886)	Zitouna	Const.	Philippeville	Skikda	Levasseur (1911)	Bir Chouhada	Batna	Canrobert	Oum El Bouaghi
Bizot (1856)	Mourad Diddouche	Const.	Const.	Const.	Lucet (1911)	Beni Guecha	Const.	Mila	Mila
Blandan	Bouteldja	Bône	Le Tarf	El Tarf	Lutaud (1914)	Boulhilet	Batna	Batna	Batna
Blondel	Aïn Sultan	Bône	Souq Ahras	Souk Ahras	Mac Donald (1881)	El Mahdia	Sétif	Sétif	Sétif
Bône	Annaba	Bône	Bône	Annaba	Mac Mahon (1894)	Aïn Touta	Batna	Batna	Batna
Bordj de Cheraya	Cheraïa	Const.	Philippeville	Skikda	Mansouria	Ziama Mansouriah	Const.	Djidjelli	Jijel
Bordj Medjana	Medjana	Sétif	Bordj Bou Arréridj	Bordj Bou Arréridj	Martimprey (1897)	Aïn Hadid	Const.	Const.	Const.
Bordj Redir	Bordj Ghdir	Sétif	Bordj Bou Arréridj	Bordj Bou Arréridj	Mesloug	Mezloug	Sétif	Sétif	Sétif
Bou Ahmar	Oued Taga	Batna	Batna	Batna	Metz		Const. (en 1876)		
Bougie	Béjaïa	Sétif	Bougie	Béjaïa	Millesimo (1848)	Belkheir	Bône	Guelma	Guelma
Bugeaud (1847)	Séraïdi	Bône	Bône	Annaba	Mondovi (1848)	Drean	Bône	Le Tarf	El Tarf
Canrobert (1904)	Oum El Bouaghi	Batna	Canrobert	Oum El Bouaghi	Montcalm (1894)	Tamlouka	Bône	Guelma	Guelma
Catinat (1906)	Settara	Const.	Didjelli	Jijel	Montesquieu (1900)	M'Daourach	Bône	Souq Ahras	Souk Ahras
Cavalio	El Aouana	Const.	Didjelli	Jijel	Morris (1878)	Ben M'Hidi	Bône	Le Tarf	El Tarf
Cerez (1906)	Belimour	Sétif	Bordj Bou Arréridj	Bordj Bou Arréridj	Mouka	Ighil Ali	Sétif	Bougie	Béjaïa
Chasseloup-Laubat (1851)	Guijel	Sétif	Sétif	Sétif	Munier (1896)	Ain Kerma	Const.	Const.	Const.
Chateaudun du Rummel (1873)	Chelgoum El Aïd	Const.	Mila	Mila	Navarin (1873)	Bir El Arch	Sétif	Sétif	Sétif
Chevreul (1898)	Arbaoun	Sétif	Sétif	Sétif	Obernai		Const. (en 1876)		
Clairfontaine	El Aouinet	Bône	Tébessa	Tébessa	Oued Amizour	Amizour	Sétif	Bougie	Béjaïa
Clauzel		Const. (en 1876)			Oued Athménia	Oued Athmania	Const.	Mila	Mila
Col des Oliviers	Ain Bouziane	Const.	Philippeville	Skikda	Oued Seguin	Oued Seguen	Const.	Mila	Mila
Colbert (1891)	Ain Oulmene	Sétif	Sétif	Sétif	Oued Zenati	Oued Zenati	Bône	Guelma	Guelma
Coligny (1853)	Bouira	Sétif	Sétif	Sétif	Paladines		Const. (en 1876)		
Combes (1881)	Asfour	Bône	Le Tarf	El Tarf	Palissy (1863)	Sidi Khaled	Batna	Biskra	Biskra
Condé-Smendou (1883)	Zighout Youcef	Const.	Const.	Const.	Pascal (1904)	Salah Bey	Sétif	Sétif	Sétif
Condorcet	Hamla	Batna	Batna	Batna	Pasteur (1883)	Seriana	Batna	Biskra	Biskra
Corneille (1904)	Merouana	Batna	Batna	Batna	Paul Doumer (1933)	Sidi Embarek	Bône	Le Tarf	El Tarf
Coulmiers		Const. (en 1876)			Penthièvre (1847)	Aïn Berda	Bône	Bône	Annaba
Delacroix		Const. (en 1876)			Périgotville (1889)	Ain El Kébira	Sétif	Sétif	Sétif
Djidjelli	Jijel	Const.	Djidjelli	Jijel	Petit (1848)	Boumahra Ahmed	Bône	Guelma	Guelma
Duquesne (1875)	Kaous	Const.	Djidjelli	Jijel	Philippeville (1841)	Skikda	Const.	Philippeville	Skikda
Duvivier (1857)	Bouchegouf	Bône	Guelma	Guelma	Pierre Curie (1907)	Oum Ladjoul	Sétif	Sétif	Sétif
Duzerville	El Hadjar	Bône	Annaba	Annaba	Praxbourg	Bouchtata	Const.	Philippeville	Skikda
Edgar Quinet (1911)	Kais	Batna	Khenchela	Khenchela	Randon (1889)	Besbes	Const.	Le Tarf	El Tarf
Eguisheim		Const. (en 1876)			Renier (1886)	Ain Makhlouf	Bône	Guelma	Guelma
El Achir	El Achir	Sétif	Bordj Bou Arréridj	Bordj Bou Arréridj	Ribeauvillé		Const. (en 1876)		
El Kseur	El Kseur	Sétif	Bougie	Béjaïa	Richelieu (1892)	Ahmed Rachedi	Const.	Mila	Mila
Faucigny (1874)		Const. (en 1876)			Robertville (1848)	Emdjez Edchich	Const.	Philippeville	Skikda
Fauvelle	El Abta	Sétif	Sétif	Sétif	Rouffach (1872)	Ibn Ziad	Const.	Const.	Const.
Foy	Menzel El Abtal	Const.	Philippeville	Skikda	Rouget de l'Isle (1919)	Souk Naamane	Batna	Canrobert	Oum El Bouaghi
Galbois (1908)	El Hanasser	Sétif	Bordj Bou Arréridj	Bordj Bou Arréridj	Saint Antoine (1844)	El hadaiek	Const.	Philippeville	Skikda
Galliéni (1858)	Bouati Mahmoud	Bône	Guelma	Guelma	Saint Charles (1847)	Ramdane Djamel	Const.	Philippeville	Skikda
Gambetta (1906)	Taouna	Const.	Philippeville	Skikda	Saint Donat (1872)	Tadjenanet	Const.	Mila	Mila
Gastonville (1848)	Salah Bouchaour	Const.	Philippeville	Skikda	Saint-Arnaud (1862)	El Eulma	Sétif	Sétif	Sétif
Gastu (1860)	Bekkouche Lakhdar	Const.	Philippeville	Skikda	Saint-Joseph (1879)	Boukamouza	Bône	Guelma	Guelma
Gounod (1899)	Aïn Larbi	Const.	Const.	Guelma	Sillegue (1885)	Beni Foudda	Sétif	Sétif	Sétif
Guelaa Bou Sba	Guelaat Bousbaa	Bône	Guelma	Guelma	Strasbourg (1873)	Emir Abdelkader	Const.	Djidjelli	Jijel
Hamma Plaisance	Hamma Bouziane	Const.	Const.	Const.	Tocqueville (1892)	Ras El Oued	Sétif	Bordj Bou Arréridj	Bordj Bou Arréridj
Herbillon (1876)	Chetaibi	Bône	Annaba	Annaba	Valée (1844)	Hamoudi Hamrouche	Const.	Philippeville	Skikda
Jean Bart (1892)	El Marsa	Const.	Philippeville	Skikda	Victor Duruy (1896)	Chaabat Ouled Chelih	Batna	Batna	Batna
Jean Rigal (1900)	Berriche	Batna	Canrobert	Oum El Bouaghi	Villars (1892)	Ouled Cheham	Bône	Guelma	Guelma
Jemmapes (1848)	Azzaba	Const.	Philippeville	Skikda	Youks les Bains	Hammamet	Bône	Tébessa	Tébessa
Kellermann (1893)	El Fedjoudj	Bône	Guelma	Guelma	Yusuf (1887)	Aïn El Hassel	Bône	Le Tarf	El Tarf
La Barbinais	Bir Aissa	Sétif	Bordj Bou Arréridj	Bordj Bou Arréridj					

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